X-6215

MAINTENANCE MANUAL

GM
GENERAL MOTORS CORPORATION
COACHES

COACH MODELS
SDH-SDM
4501, 5301
TDH-TDM
4516, 4517, 5301, 5302

GMC TRUCK & COACH DIVISION
GENERAL MOTORS CORPORATION
Pontiac, Michigan

X-6215 5M 6-62
Printed in U.S.A.
Reprinted 1M 11-63

INDEX

INTRODUCTION

This manual contains complete service, maintenance, and repair information on GM Suburban and Transit Coaches. Information in this manual pertains to standard equipment and the most commonly used special equipment.

Operation of the vehicle from the standpoint of the driver is contained in a separate Operating Manual. For information on the Diesel Engine, refer to the current Diesel Engine Maintenance Manual. For information on the Hydraulic Drive Transmission, refer to the current Hydraulic Drive Maintenance Manual.

Every effort has been made to include timely and adequate information on the various units and systems used on these coaches. The maintenance and repair procedures in the various manual sections are the result of extensive service experience. This information should serve not only as a reference for the experienced mechanical force, but also as a comprehensive text for training purposes.

All information contained in this manual is based on the latest product information available at the time of publication approval. GMC Truck and Coach Division reserves the right to make product changes at any time.

GENERAL INFORMATION ABOUT THIS MANUAL

MANUAL ARRANGEMENT

This manual is divided into major sections in the sequence shown on the margin of the title page. A black tab bearing the major section number is placed on the first page of each major section which indexes with the tab on the title page. Many of the major sections are divided into sub-sections, each sub-section containing important and specific information on related units or components. When a major section is divided into sub-sections, a section index appears on the first page of the major section.

PAGE AND ILLUSTRATION NUMBERS

The manual pages are numbered consecutively throughout the manual. Illustrations are numbered consecutively within each section, or within each sub-section when the major section is so divided.

SPECIFICATIONS

Service data, fits, and tolerances are listed at the end of most sections or sub-sections under the heading "Specifications." Manufacturers model or part numbers are used in many instances in the "Specifications" tabulation. These numbers are provided primarily for unit identification and should be referred to when ordering parts. All detail service part numbers must be obtained from the applicable Parts Book.

SPECIAL TOOLS

Special tools and equipment are mentioned, and in many instances illustrated, throughout the text. These tools are specially designed to accomplish certain operations efficiently and readily. Such tools are identified in the text by tool vendor's numbers. These tools are not offered for sale by GMC Truck and Coach Division. Information regarding availability of these tools can be obtained from your GM Coach Service Representative or from the Factory.

SERVICE BULLETINS

Service bulletins are issued, when required, supplementing or in some cases superseding information in this manual. Information in these bulletins should be noted in the text and the bulletin filed for ready reference.

ALPHABETICAL INDEX

Important subjects, with manual page number references, are alphabetically listed at the end of this manual.

GENERAL DATA

The data listed below covers only general information on Coaches covered by this manual. For specific data and specifications on any unit or system, refer to "Specifications" at end of each manual section.

MODEL DATA

	SDH-4501 SDM-4501	TDH-4516	TDH-4517 TDM-4517	TDH-5301 TDM-5301	SDH-5301 SDM-5301	TDH-5302 TDM-5302
Length (Maximum)	35′	35′	35′	40′	40′	40′
Width (Maximum)	95¾″	101¾″	95¾	101¾″	95¾″	95¾″
Height (Maximum)	117 53/64″	118″	118″	118″	118 7/16″	118″
Track						
Front	79¼″	85¼″	79¼″	85¼″	79¼″	79¼″
Rear (Center of Dual Tires)	70½″	76½″	70½″	76½″	70½″	70½″
Turning Radius						
Wheel (Right and Left)	31′ 2″	32′ 4″	32′ 2″	37′ 3″	36′ 4″	37′ 1″
Body Corner (Right and Left)	36′ 1″	37′ 3″	37′ 1″	42′ 3″	41′ 4″	42′ 1″
Wheelbase	235″	235″	235″	284¾″	284¾″	284¾″
Tire Size (Single Front-Dual Rear)	10.00/20	11.00/20	10.00/20	11.00/20	11.00/20	11.00/20

SERIAL NUMBER LOCATIONS

Delay and confusion can be avoided when correct serial numbers of vehicle and engine are placed on parts orders and correspondence. Locations of these serial numbers are illustrated below.

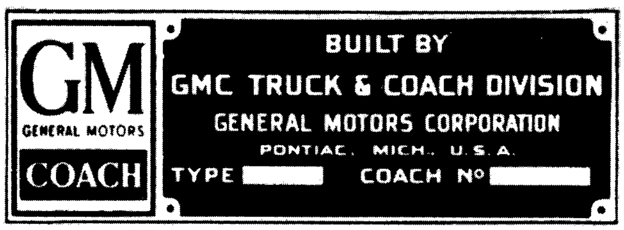


PLATE ON DASH COMPARTMENT DOOR

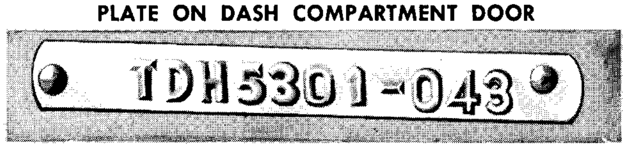
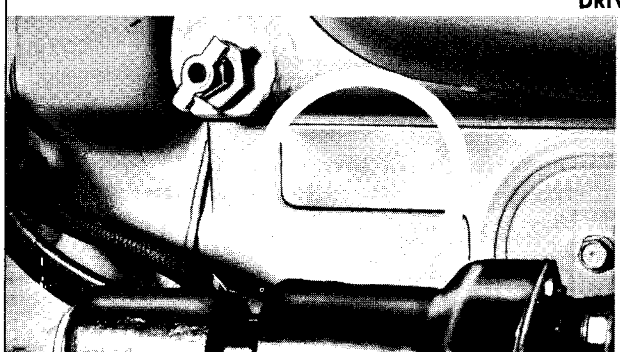
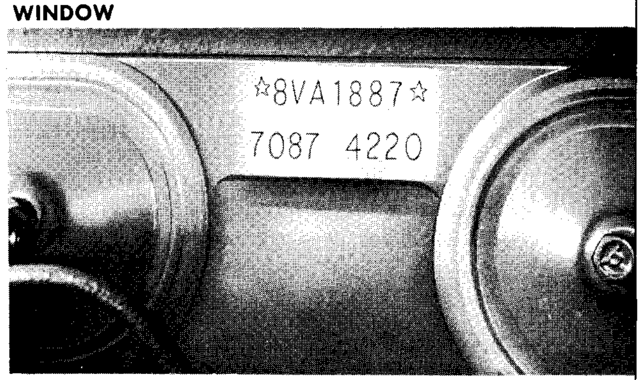


PLATE ON TRIM PANEL BELOW DRIVER'S WINDOW



6-CYLINDER ENGINE—RIGHT SIDE OF CYLINDER BLOCK ABOVE STARTER



8-CYLINDER ENGINE—RIGHT SIDE OF CYLINDER BLOCK AT CENTER

TPM-9503

Front Axle

This group is divided into two sections covering "FRONT END ALIGNMENT" and "FRONT AXLE REPAIR."

Front End Alignment

Proper front end alignment must be maintained to insure ease of steering and satisfactory tire life.

Front end alignment inspections generally fall into two groups: (1) regular service inspections performed at periodic intervals, and (2) inspections to determine extent of damage after a collision or severe service.

Regular service inspections are primarily concerned with toe-in, camber, and caster; with proper equipment these specifications are easily checked. Any variation from these specifications will indicate: (1) need for adjustments, or (2) more thorough inspection to determine if any steering or front axle parts are bent and require replacement.

Complete front end alignment data is given under "Specifications" at end of this section.

DEFINITION OF TERMS

WHEEL TOE-IN. Distance front wheels are closer together at front than at rear of axle (see "G" and "H," fig. 1).

WHEEL CAMBER. Amount wheels are inclined from vertical plane (see "C," fig. 1).

FRONT AXLE CASTER. Inclination of king pin from the vertical in the fore and aft direction of the vehicle (see "X," fig. 1).

KING PIN INCLINATION. The slant of the king pin toward the center of the vehicle at the top and outward at the bottom (see "D," fig. 1).

STEERING GEOMETRY. The design of the front end which causes the front wheels to stay in proper relative alignment when the wheels are turned to right or left.

FRONT END INSPECTION

Before checking front end alignment the following front end inspection should always be made:

1. Check tires for proper inflation.
2. Check wheel installation and run-out.
3. Check wheel bearing adjustment.
4. Check tie rod and drag link ends for looseness.
5. Check king pins for looseness.

Front end alignment requires the vehicle to be level while being checked. Full weight must be on wheels with vehicle empty.

ALIGNMENT

FRONT WHEEL TOE-IN

Toe-in may be measured from centers of tire tread or from inside of tires or rims. Measurements at both front and rear of axle (see "H" and "G," fig. 1) must be made at same height from floor.

If measurement is to be made from centers of tire treads, first hoist front of vehicle and spin wheels to obtain a center line on tire treads.

Place wheels in straight-ahead position.

Roll the vehicle straight ahead for several feet to where the inspection is to be made. This will remove any slack caused by looseness in the wheel bearings or steering connections.

Measure at point "H" and "G" (fig. 1). Toe-in is "G" minus "H."

Some toe-in gauges are designed for measuring between the front wheels on the rim or on the tire. If such a gauge is used, measure first at "H." Mark point on tire or rim at which measurement is taken. Roll vehicle forward until mark on tire or rim is at same height at rear as it was at front, then measure "G." Never allow vehicle to roll backwards while checking toe-in.

Incorrect toe-in results in excessive tire wear caused by side slippage. Unstable steering with a tendency to wander may also result.

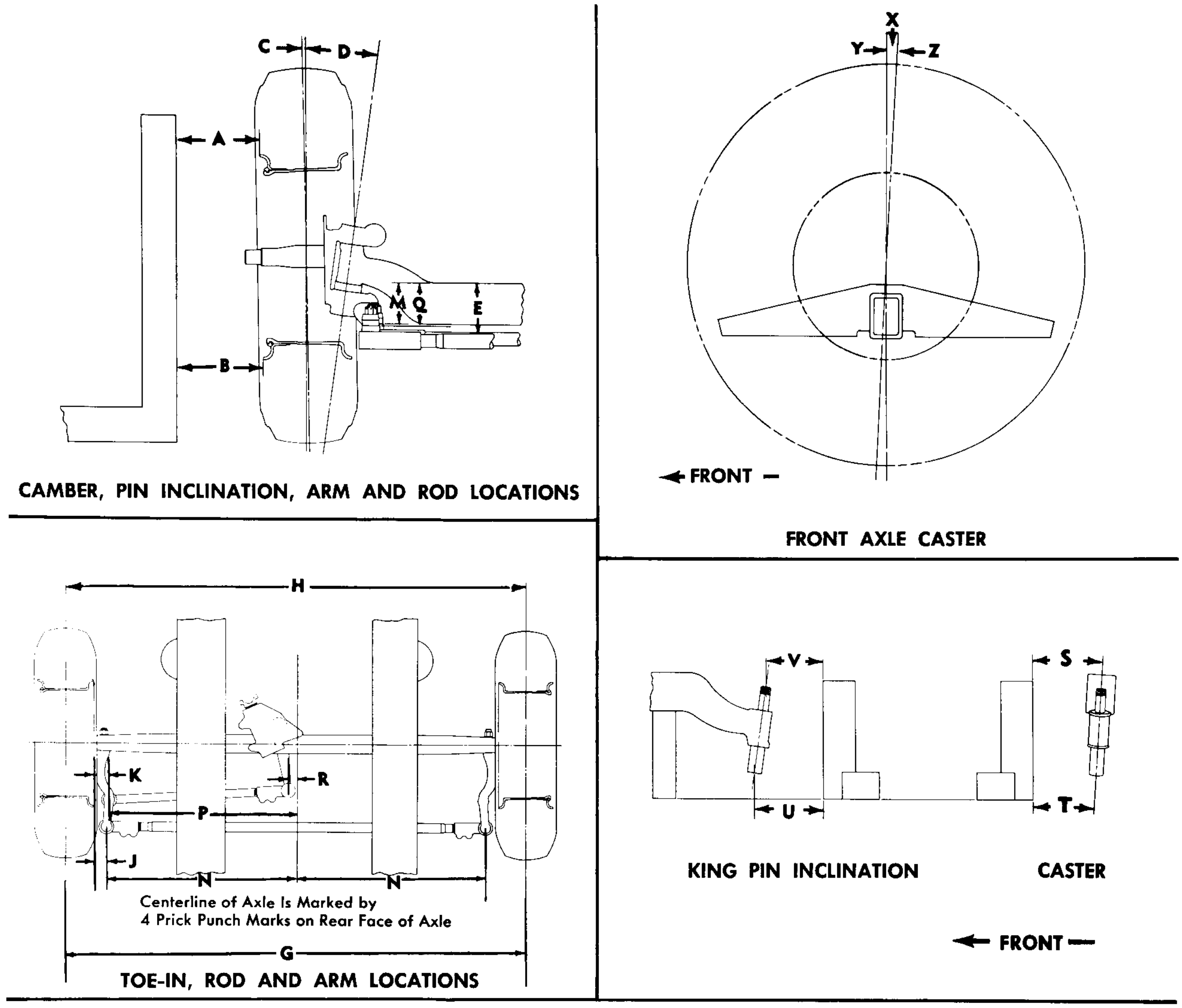
TOE-IN ADJUSTMENT

1. Loosen clamp bolts which retain each tie rod end on tie rod.
2. Using a pipe wrench, turn tie rod tube as required to obtain correct toe-in measurement.
3. After correct adjustment is obtained, make certain that both tie rod ends are in the same plane; then tighten all clamp bolts firmly.
4. Recheck toe-in to make sure adjustment was not changed when clamp bolts were tightened.

FRONT WHEEL CAMBER

Positive Camber is outward inclination of wheels at top. Negative or Reverse Camber is inward inclination of wheels at top. These vehicles are designed with positive camber. Camber variations may be caused by wear at wheel bearings and steeringing knuckle bushings, or by a bent

FRONT END ALIGNMENT



B Minus A . . Camber (Inches)
C . . . . Camber (Degrees)
D . . . . King Pin Inclination (Degrees)
E . . . . Top of Tie Rod Tube Below Top of Axle
G Minus H . . Front Wheel Toe-in (Inches)
J . . . . Centerline of tie Rod End Stud to Wheel Rim
K . . . . Centerline of Drag Link End Stud to Wheel Rim
M . . . . Bottom of Steering Arm Boss to Top of Axle Beam
N . . . . Centerline of Axle to Center of Tie Rod End Studs
P . . . . Centerline of Axle to Center of Steering Arm End (at Drag Link)
Q . . . . Bottom of Tie Rod Arm Boss to Top of Axle Beam
R . . . . Centerline of Axle to Center of Pitman Arm Stud
S Minus T . . Caster (Inches) (Measure at Front of Axle)
U Minus V . . King Pin Inclination (Inches)
X . . . . Caster (Degrees)
Y . . . . Vertical
Z . . . . Centerline of King Pin

Refer to "Wheel Alignment Dimensions" for numerical values.

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Figure 1—Front End Alignment Chart

steering knuckle or sagging axle center.

In checking camber, it is recommended that an accurate gauge be used. If a camber gauge is not available, readings can be taken as illustrated at "A" and "B" on chart (fig. 1). Place square as shown and measure distance between "A" and rim, and "B" and rim. Lower dimension should exceed upper dimension by amount listed in "Specifications" at end of this section. This dimension on right wheel should not vary over 3/32" from same dimension taken at left wheel.

If final camber reading is incorrect, either steering knuckle or axle center is bent. To determine which part is bent, check king pin inclination ("D," fig. 1). Camber plus king pin inclination is the INCLUDED ANGLE of steering knuckle. If included angle of knuckle varies more than 1/2 degree from value given in "Specifications," knuckle is bent.

Excessive positive camber results in irregular wear of tires at outer shoulders. Negative or reverse camber causes wear at inner shoulders. Ease of steering is affected by any deviation from specified camber.

AXLE CASTER

Positive Caster is the inclination of the king pins toward rear of vehicle. Negative or Reverse Caster is the inclination of king pins toward front of vehicle. These vehicles are designed with positive caster.

Caster variations may be caused by uneven tightening of suspension support studs or bent axle. Precision instruments must be used to check caster angles when axle is installed in vehicle.

Caster can be adjusted on vehicle by loosening clamp bolts in adjusting clamp on upper radius rod as shown in figure 2. By turning clamp, adjust caster to dimension listed in "Front End Alignment Data" at end of this section. Tighten clamp bolts firmly after adjustment.

When axle is removed from vehicle, check can be made on bench as follows:

Place two uniform blocks on level surface, rest suspension support seats on blocks. Using square, measure "S" and "T" at front side of axle (fig. 1); dimensions "S" minus "T" equals caster in inches. If this dimension does not agree with specified value, then axle is twisted.

The purpose of caster is to provide steering stability by keeping the wheels in a straight-ahead-position. Variations from specified caster values will affect steering stability causing wandering, difficulty in pulling out of curves, and a tendency toward wheel shimmy.

KING PIN INCLINATION

Precision instruments must be used to check king pin inclination when axle is installed in vehicle. When axle is removed, check can be made on bench as follows:

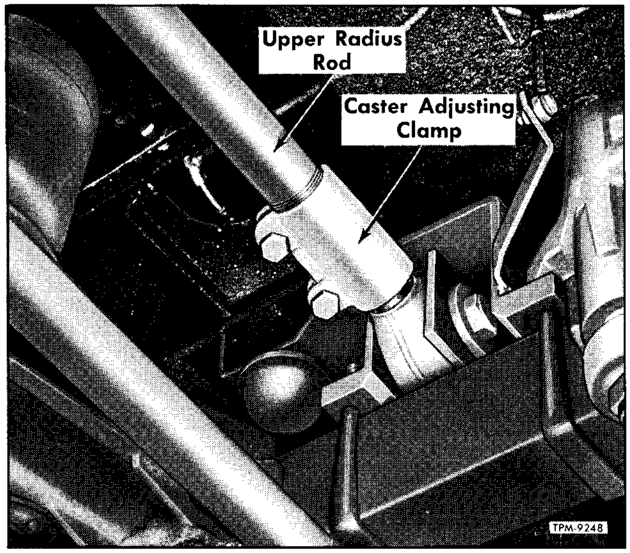


Figure 2—Caster Adjusting Clamp

Place two uniform blocks on level surface, rest suspension support seats on blocks. Using square, measure "U" and "V" dimensions (fig. 1). "U" minus "V" equals king pin inclination in inches.

If axle is bent or twisted, refer to "Straightening Axle Center" later in this section for corrective information.

STEERING GEOMETRY

Since the angularity of the steering arms largely control steering geometry, checking the alignment of the steering arms and linkage is an important alignment factor.

After making all other front end alignment checks, inspect steering arms for proper installation, then measure steering arm angles as follows:

1. Top of tie rod tube below top of axle ("E," fig. 1).
2. Centerline of tie rod end stud to edge of wheel rims ("J," fig. 1).
3. Centerline of drag link end stud to edge of wheel rim ("K," fig. 1).
4. Bottom of steering arm boss to top of axle beam ("M," fig. 1).
5. Centerline of axle to center of tie rod end studs ("N," fig. 1).
6. Centerline of axle to center of steering arm end (at drag link) ("P," fig. 1).
7. Bottom of tie rod arm boss to top of axle beam ("Q," fig. 1).
8. Centerline of axle to center of pitman arm stud ("R," fig. 1).

If these dimensions (see "Specifications") are not within specified values, then the steering arm or steering linkage is bent and should be replaced.

ALIGNMENT SPECIFICATIONS

(REFER TO ALIGNMENT CHART, FIGURE 1)
(DIMENSIONS ARE THE SAME FOR ALL MODELS UNLESS OTHERWISE SPECIFIED)

CODE	ITEM	DIMENSION
B-A	Wheel Camber (Inches)	13/32
C	Wheel Camber (Degrees)	1
D	King Pin Inclination (Degrees)	8
E	Top of Tie Rod Tube Below Top of Axle (Inches)	6 Plus or Minus 1/8
G-H	Front Wheel Toe-In (Inches)	1/8 Plus or Minus 1/32
J	Centerline of Tie Rod End Stud to Wheel Rim (Inches)	2 15/32
K	Centerline of Drag Link End Stud to Wheel Rim (Inches)	2 7/8
M	Bottom of Steering Arm Boss to Top of Axle Beam (Inches)	4 3/4
N	Centerline of Axle to Center of Tie Rod End Studs (Inches)	
	SDH & SDM-4501; TDH & TDM-4517; SDH & SDM-5301; TDH & TDM-5302	32 5/32
	TDH-4516; TDH & TDM-5301	35 5/32
P	Centerline of Axle to Center of Steering Arm End (At Drag Link) (Inches)	
	SDH & SDM-4501; TDH & TDM-4517; SDH & SDM-5301; TDH & TDM-5302	31 23/32
	TDH-4516; TDH & TDM-5301	34 23/32
Q	Bottom of Tie Rod Arm Boss to Top of Axle Beam (Inches)	5
R	Centerline of Axle to Center of Pitman Arm Stud (Inches)	1 3/4
S-T	Caster (Inches) (Measured at Front of Axle)	5/16
U-V	King Pin Inclination (Inches)	1 1/2
X	Caster (Degrees) (With Axle Installed)*	1 1/2 to 2
	Front Wheel Track at Ground (Inches)	
	SDH & SDM-4501; TDH & TDM-4517; SDH & SDM-5301; TDH & TDM-5302	79 1/4
	TDH-4516; TDH & TDM-5301	85 1/4

*Specification for bench inspection is 3 degrees.

Front Axle Repair

Front axle assembly is reverse Elliott type. Axle steering knuckles are constructed as shown in figure 1.

Wheel bearings, air suspension, steering, and brake parts which are mounted on front axle, are described in their respective sections in this manual.

Specifications and pertinent front axle service information are given in "Specifications" at end of this section.

FRONT AXLE CONSTRUCTION

Front axle assembly center section is a hollow rectangular tube in which dowel pins are installed to locate air suspension supports and radius rod brackets. Outer ends of axle center are solid forgings machined to accommodate steering knuckles and king pins. Outer ends are welded to axle center in an offset position to form the built-in caster angle of the axle.

Steering knuckles (fig. 1) are supported on solid king pins which are tapered at center section to fit snugly in tapered holes in axle outer ends. Nut installed at threaded upper end of each king pin draws bushing (3) against spacer (4) and secures king pin in axle. Cotter pins are used to secure king pin nuts.

Load is transmitted from axle center to knuckle through tapered roller thrust bearings (9, fig. 1). Covers and plugs (2 and 7, fig. 1) exclude dust and moisture from knuckle bushings and serve as lubricant seals. Steering knuckle bushings can be replaced.

Left steering tie rod arm has two holes, the rear of which is to accommodate tie rod, and the front to accommodate the drag link. The steering gear assembly is mounted directly on axle center.

Stop screws installed at each end of axle center limit turning angle of front wheels.

FRONT AXLE GENERAL MAINTENANCE

INSPECTION

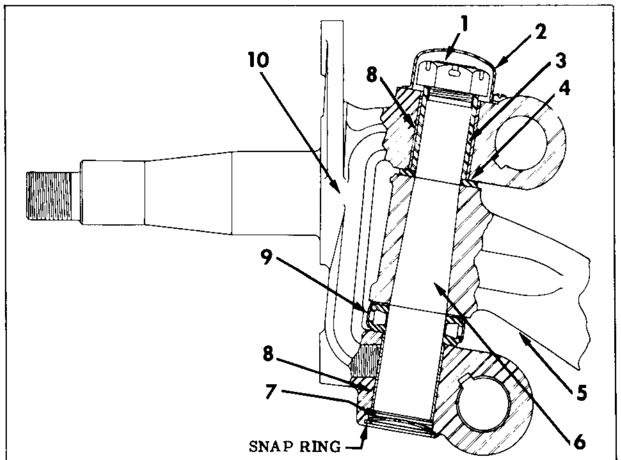
Following inspection operations should be performed at intervals determined by severity of service.

1. Inspect air suspension support stud nuts and U-bolt nuts, and radius rod stud nuts and U-bolt nuts. Tighten as directed in "AIR SUSPENSION" (SEC. 14).
2. Inspect and tighten tie rod and drag link end stud nuts as directed in STEERING (SEC. 16).
3. Inspect tie rod ends for wear. If worn, replace as instructed in STEERING (SEC. 16).
4. Lubricate front axle parts as instructed in LUBRICATION (SEC. 13).
5. When steering difficulty or abnormal tire wear indicate necessity, check front end alignment as previously instructed under "FRONT END ALIGNMENT."
6. Inspect king pin and steering knuckle bushings for wear.
7. Check up and down movement of knuckles on king pins. Excessive movement will pound and damage the thrust bearings. Refer to "Specifications" for minimum axle to knuckle clearance.
8. Check stop screws and adjust when necessary. Stop screw adjustment procedure is described later.

STOP SCREWS

Adjustable stop screws limit front wheel turning angle to right and left. Stop screws must be set to give maximum turning radius to the right and to the left and at the same time prevent interference between front tires and other parts of coach.

Before setting stop screws, refer to STEERING GEAR (SEC. 16) and be sure pitman arm is properly installed on steering gear, and be sure steering gear drag link is properly adjusted for length and not distorted or bent.



1 King Pin Nut	7 Expansion Plug
2 King Pin Cover	8 Steering Knuckle Bushing
3 King Pin Bushing	9 Thrust Bearing Assembly
4 Spacing Washer	10 Steering Knuckle
5 Axle Center End	
6 King Pin	

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Figure 1—Steering Knuckle Assembly

FRONT AXLE REPAIR

Adjust stop screws as follows:

1. Raise front axle until front wheels are off floor.

2. Turn wheel to extreme left until drag link tube contacts lower radius rod bracket, then turn axle stop screw out to engage knuckle. This should provide 1/2 to 3/4 inch clearance between bellows lower piston and tire. Tighten stop screw lock nut.

3. Turn wheel to extreme right until drag link socket contacts tie rod tube, then turn axle stop screw out to engage knuckle. This should provide 1/2 to 3/4 inch clearance between bellows lower piston and tire. Tighten stop screw lock nut.

4. When adjustment is completed, road test coach and note if any interference takes place between tires and other parts of coach while making sharp turns in either direction.

FRONT AXLE REPLACEMENT

Procedures covering replacement of front axle assembly, including suspension components which are attached to the axle, and replacement of suspension components on axle assembly are covered in AIR SUSPENSION (SEC. 14).

FRONT AXLE OVERHAUL

Steering knuckles, king pins, and bushings can be replaced, and minor axle straightening can be performed without removing front axle assembly from vehicle. However, when front axle assembly requires a complete overhaul, the assembly should be removed.

Certain preliminary inspections can be made, while axle is still mounted on vehicle, which will aid in determining the amount of repair work necessary.

Check front end alignment as directed in "FRONT END ALIGNMENT" previously in this group.

Inability to align front end correctly indicates that axle center or steering knuckle has been distorted, steering arms have been bent, or bushings in steering knuckles are worn beyond limits.

Repair procedures on such items as AIR SUSPENSION, WHEEL BEARINGS, BRAKES, SHOCK ABSORBERS, AND STEERING are covered in their respective sections of this manual.

STEERING KNUCKLE REMOVAL

If desired, steering knuckles may be removed from front axle without removing front axle assembly from the vehicle. To remove steering knuckles from the axle either with or without removing the front axle assembly from vehicle, proceed as follows:

1. Remove tie rod and drag link as directed in STEERING (SEC. 16) of this manual.

2. Remove front wheels, hubs, and bearings. Refer to HUBS, WHEELS, AND TIRES (SEC. 19).

3. Remove air brake mechanism and brake shoes. Detach brake shoe spider from knuckle and remove spider, camshaft, and slack adjuster as an assembly.

4. Remove nuts from steering arms and drive arms out of steering knuckles.

5. Remove cover (2, fig. 1) from top of knuckle to expose king pin nut. Remove lock ring from knuckle lower yoke and remove plug.

6. Remove cotter pin, then remove nut from upper end of king pin. Using suitable brass drift, drive king pin downward out of axle and knuckle. Remove knuckle, thrust bearing, and spacing washer from axle. King pin bushing can be lifted out of knuckle upper yoke.

CLEANING

Wash steering knuckle parts in cleaning solution, being sure to remove all dirt and lubricant. If necessary, soak thrust bearings in cleaner until all old lubricant is dissolved; then slush bearing in cleaning solution until all grit is removed from races.

INSPECTION AND REPAIR

STEERING KNUCKLES

After steering knuckles have been cleaned, thoroughly examine knuckles for distortion, damage, cracks, or fractures. If Magna-Flux inspection equipment is available, use this method to inspect steering knuckles and king pins for minute cracks, checks, or fractures which otherwise would not be visible to the naked eye.

AXLE CENTER

There are two conditions which, if either exists, will necessitate replacement of axle center.

1. If king pin holes in axle center ends are worn to such an extent that a new pin fits loosely, axle center must be replaced.

2. If axle center has been twisted or bent more than 5 degrees from original shape, the center should be replaced. When an extreme bent condition exists, minute invisible fractures may occur and cause failure under ordinary operating conditions.

CHECKING AXLE CENTER

Check axle center for twist with alignment

instruments, or on a bench as illustrated in front end alignment chart. If equipment is available, use Magna-Flux method to check axle center for minute fractures.

STRAIGHTENING AXLE CENTER

The straightening of axle forgings must be performed by mechanics who are thoroughly familiar with such operations and use special straightening tools. ALWAYS STRAIGHTEN FORGINGS COLD -- UNDER NO CIRCUMSTANCES SHOULD HEAT BE APPLIED. Application of heat to facilitate straightening weakens the material strength of all forgings.

THRUST BEARING

Examine thrust bearings for excessive wear, pitting, or other damage. If these conditions are evident or if bearing retainers are bent or damaged, bearings should be replaced.

BUSHING REPLACEMENT

Steering knuckle bushings should be replaced if inspection reveals that they are scored, worn, or otherwise damaged.

Removal

1. Clamp steering knuckle securely in vise equipped with soft jaws.
2. Thread tap of suitable size into bushing, if bushing driver is not available.
3. Using soft metal rod, slightly smaller than bushing and long enough to extend at least 1-1/2" through opposite knuckle yoke, drive tap and bushing out of knuckle bore.
4. Repeat process to remove remaining steering knuckle bushing.

Installation

1. Clean the steering knuckle bushing bores, then round off all sharp edges of new bushings slightly.
2. Position bushing so that oil hole in bushing will line up with lubrication fitting hole in steering knuckle yoke, and so that bushing will enter knuckle bore straight when pressed into yoke.
3. Using arbor press and suitable installer, press bushing into knuckle bore until positioned as shown in figure 1. NEVER ATTEMPT TO DRIVE BUSHINGS WITH HAMMER.
4. Ream or hone bushings to diameter given in "Specifications" at end of this section.
5. Clean cuttings out of oil grooves, then round off all sharp edges in grooves.

KING PIN

Check diameter of king pin at upper and lower bearing surfaces against dimensions given in "Specifications" at end of this section. If wear exceeds limits given, replace with new king pin.

King pins should also be inspected for minute cracks or other damage.

STEERING KNUCKLE INSTALLATION

The importance of cleanliness when assembling steering knuckle parts cannot be overstressed. If the king pins and bushings are installed with particles of dirt or metal between bearing surfaces, excessive wear will result necessitating premature replacement of parts.

Install steering knuckles and king pins in the following manner. Key numbers in text refer to figure 1.

1. Position steering knuckle (10) on axle center end (5), then slide thrust bearing assembly (9) into place between lower face of axle center and steering knuckle lower yoke. Make sure retainer is on top of bearing with lip of retainer down. Align king pin holes in steering knuckle yokes with king pin hole in axle center end.
2. With axle center held rigidly, place a jack under knuckle yoke and raise knuckle sufficiently to take up all clearance between lower yoke, thrust bearing, and lower face of axle center end.
3. Check clearance between top face of axle center end and lower face of steering knuckle yoke, then select shim and spacing washer combination which will reduce clearance to limits given in "Specifications" at end of this section. Shim and spacing washer thicknesses available are given in "Specifications" at end of this section.
4. Make certain king pin hole in axle center (5), king pin (6), and nut (1) are carefully cleaned and dry. King pin nut (1) should screw on king pin freely without binding in any manner. These precautions should be taken to assure king pin being securely locked in place when installation is completed.
5. Insert king pin (6) through bottom yoke of steering knuckle (10), then drive king pin into place with lead hammer.
6. Place king pin bushing (3) over threaded end of king pin (6), and into knuckle upper yoke.
7. Make sure threads on king pin nut are clean and dry, then install king pin nut (1). Tighten nut with torque wrench to minimum torque given in "Specifications" at end of this section, then tighten nut until next castellation on nut lines up with cotter pin hole through king pin. Install new cotter pin, full size of cotter pin hole.
8. Position new cover gasket on steering knuckle upper yoke, place dust cap (2) on gasket, then secure cover with attaching screws.
9. Install new plug (7) in lower yoke, then install lock ring to retain plug. Install plug with concave side toward lock ring so edge of plug contacts ring.

FRONT AXLE REPAIR

10. Place keys in keyways in steering arms and drive arms into tapered holes in knuckles. Install nuts on arms and tighten nuts to torque specified in "Specifications" at end of this section. Secure nuts with cotter pins.

11. Install brake spider and camshaft assembly on knuckle, install brake chambers, and connect chamber push rods to slack adjusters. Install brake shoes, hubs and bearings, and brake drums. Refer to HUBS, WHEELS, AND TIRES (SEC. 19) for instructions for adjusting wheel bearings.

12. Install tie rod assembly and connect drag link to steering arm at left steering knuckle as directed in STEERING (SEC. 16) of this manual.

FRONT AXLE SPECIFICATIONS

ITEM	DIMENSION
STEERING KNUCKLE	
Spindle Diameter	
At Outer Wheel Bearing	2.1243"-2.1248"
At Inner Wheel Bearing	2.5613"-2.5623"
Steering Knuckle Bushings	
Inner Diameter	1.7965"-1.7975"
Length	2 3/16"
King Pin Bushing	
Inner Diameter	1.310"-1.311"
Outer Diameter	1.7930"-1.7940"
Length	2 15/32"
KING PIN	
Diameter at Top of Pin	1.3085"-1.3095"
Diameter at Bottom of Pin	1.7930"-1.7940"
Length (Overall)	10 3/4"
FITS AND TOLERANCES	
Clearance Between	
King Pin Bushing and Knuckle Bushing	0.0025"-0.0045"
King Pin and Lower Knuckle Bushing	0.0025"-0.0045"
Axle Center to Steering Knuckle Clearance	0.015" Max.
Means of Adjustment	Shims and Spacing Washers
Shim Thickness	0.015"
Spacing Washer Thicknesses Available	0.093", 0.125", and 0.156"
TORQUE SPECIFICATIONS	
Steering Arm to Knuckle Nut	350-390 Ft.-Lbs.
King Pin Nuts	350-390 Ft.-Lbs.

Rear Axle

Rear axle is full-floating type, using a one-piece axle housing with housing bowl cover welded to housing. Housing bowl is located to the left of axle center line.

As shown in figure 1, drive pinion assembly is mounted at an angle to drive gear, thus increasing the tooth contact area between drive gear and drive pinion gear teeth. Drive is transmitted from transmission angle drive unit through propeller shaft to spiral bevel gears, axle housing, and then to vehicle underframe through upper and lower radius rods.

Differential and drive pinion assemblies are both provided with facilities for adjustment of bearings and gear tooth contact.

DIFFERENTIAL CARRIER

Differential assembly, drive pinion, and pinion cage assembly are mounted in differential carrier. After axle shafts have been removed, and propeller shaft has been disconnected, differential carrier can be removed for inspection and adjustment without removing axle housing from vehicle as directed later in this section.

DIFFERENTIAL ASSEMBLY

Conventional four-pinion type differential is carried in two-piece case mounted on tapered roller bearings. Bevel drive gear is bolted to flanged half of differential case. Drive gear and pinion are furnished in matched, lapped sets, and should always be installed as such to assure satisfactory operation.

Thrust washers are used between differential side gears and case, also between differential pinions and case. Differential case halves are held together with special bolts and slotted nuts, locked in place with lock wire.

DIFFERENTIAL SIDE BEARINGS

Differential is supported in tapered roller bearings which take thrust as well as radial loads. Bearings are mounted in machined supports in differential carrier with thrust loads taken by adjusting rings threaded into carrier supports and bearing caps. Adjusting rings bear against bearing cups and are locked in position by adjusting ring locks bolted to each bearing cap.

2

PINION AND CAGE ASSEMBLY

Bevel drive pinion is installed at an angle in differential carrier. Pinion is straddle mounted in two opposed tapered roller bearings at outer end, and one straight roller bearing at inner end.

Tapered roller bearing cups installed in pinion cage are separated by a machined shoulder in pinion cage.

Pinion bearings are adjusted on shaft by selecting a spacer of correct thickness as described later in this section under "Drive Pinion and Cage Assembly."

Straight roller bearing at inner end of drive pinion is secured in place with a snap ring.

Shims of various thicknesses are used between pinion cage and differential carrier to adjust drive pinion tooth contact and gear backlash.

Pinion shaft and cage assembly cannot be removed from carrier until differential assembly has been removed from carrier.

AXLE SHAFTS AND HOUSING

Axle shafts are full floating type. Drive flange at outer end is attached to hub by studs, nuts, and tapered dowels; inner end of shaft is splined to differential side gear.

Axle housing is one-piece design with differential located off center. Housing is equipped with outer end tubes which are threaded to accommodate wheel bearing adjusting nuts.

MAINTENANCE ON VEHICLE

The following maintenance operations should be accomplished at regular inspection and lubrication intervals.

LUBRICATION

Lubrication checking and draining intervals and filling instructions, also type of lubricant and capacity, are given in LUBRICATION (SEC. 13).

Examine pinion oil seal, axle shaft flange, and carrier to housing gaskets for evidence of lubricant leakage. Tighten bolts or nuts, or replace gaskets and seals to correct leaks.

MOUNTING

Maintenance of the axle mounting on vehicle consists primarily of a regular and systematic

REAR AXLE

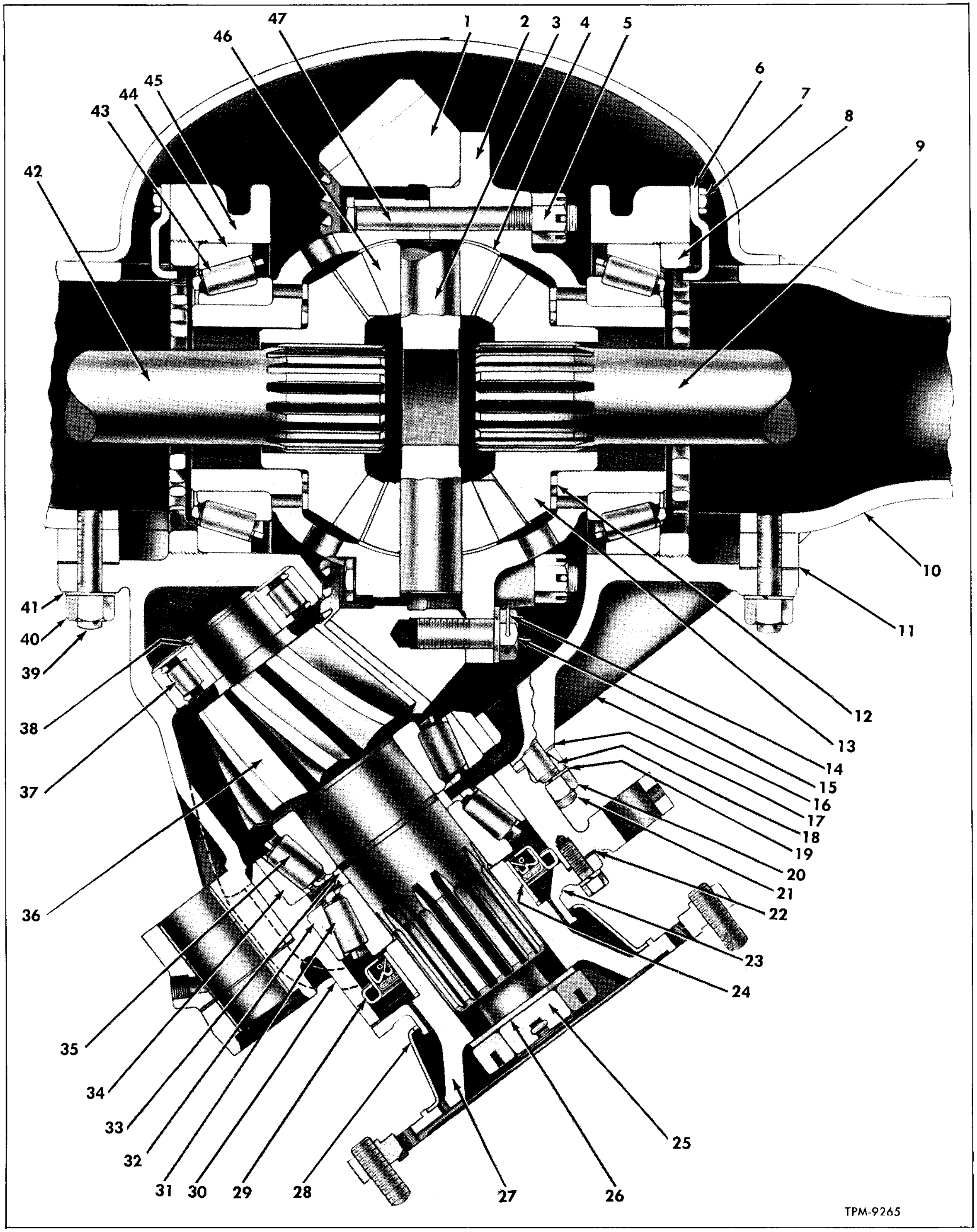


Figure 1—Sectional View Of Rear Axle

1 Drive Gear	17 Pinion Cage Shims	32 Pinion Bearing Cup - Outer
2 Differential Case	18 Pinion Cage Tapered Dowel	33 Pinion Bearing Spacer
3 Differential Spider	19 Lock Washer	34 Pinion Bearing Cup - Inner
4 Pinion Thrust Washer	20 Stud Nut	35 Pinion Bearing Cone - Inner
5 Case Bolt Nut	21 Pinion Cage Stud	36 Drive Pinion
6 Adjusting Ring Lock	22 Pinion Oil Seal Retainer Gasket	37 Pinion Bearing
7 Lock Bolt		38 Bearing Retainer Ring
8 Bearing Adjusting Ring	23 Pinion Oil Seal Retainer	39 Carrier Stud
9 Axle Shaft (Right)	24 Oil Seal Sleeve	40 Stud Nut
10 Axle Housing	25 Pinion Nut	41 Lock Washer
11 Carrier Gasket	26 Pinion Nut Washer	42 Axle Shaft (Left)
12 Side Gear Thrust Washer	27 Propeller Shaft Flange	43 Differential Bearing Cone
13 Differential Side Gear	28 Dust Slinger	44 Differential Bearing Cup
14 Bolt Lock Wire	29 Pinion Oil Seal Assembly	45 Differential Bearing Cap
15 Drive Gear Bolt	30 Pinion Cage	46 Differential Pinion
16 Differential Carrier	31 Pinion Bearing Cone - Outer	47 Differential Case Bolt

Captions For Figure 1—Opposite Page

inspection of air suspension units and radius rods as directed in AIR SUSPENSION (SEC. 14).

AXLE SHAFT AND PINION CAGE MOUNTING

Axle shafts and pinion cage are retained with stud nuts, lock washers, internal-tooth lock washers, and split tapered dowels. The studs must be straight and dowels of correct taper must be used. There should always be a slight clearance between nuts and mounting flange when nuts are tight.

Whenever inspection shows that no clearance exists between nut and flange, this indicates that excessive wear exists at tapered dowels, studs, or tapered holes in drive flange.

If stud nuts are not tightened to recommended torque, play at flange and broken or worn studs will result and damaged parts must be replaced.

AXLE OVERHAUL

Rear axle may be disassembled while the housing remains installed in vehicle if proper equipment is available for handling differential assembly. Information on suspension, propeller shaft, brakes, hubs, bearings, wheels, and tires will be found in respective sections of this manual.

REAR AXLE REPLACEMENT

Complete instructions for removal and installation of rear axle assembly will be found in AIR SUSPENSION (SEC. 14).

AXLE SHAFT REPLACEMENT

The following procedures for removal and installation of axle shafts is applicable regardless whether the axle assembly is removed or installed on the vehicle. Axle shafts are fastened by either seven or ten studs and nuts, dependant upon model.

REMOVAL

1. Remove nuts and washers from hub studs.
2. Strike center of flange with a lead hammer to loosen flange and dowels from studs.
3. If shaft is not loose enough to pull by hand, thread 1/2-13 puller screws in holes provided (either two or three tapped holes).
4. Tighten puller screws evenly and alternately until flange is pulled from hub studs. Withdraw axle shaft from housing, then remove gasket from hub or flange.

INSTALLATION

1. Install and adjust hubs and bearings as directed in WHEELS, HUBS, AND TIRES (SEC. 19).
2. Install new gasket over hub studs.

NOTE: Observe that oil seal assembly and wiper are installed at outer side of hub.

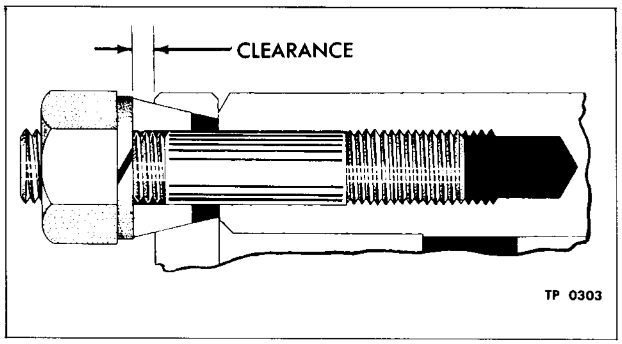
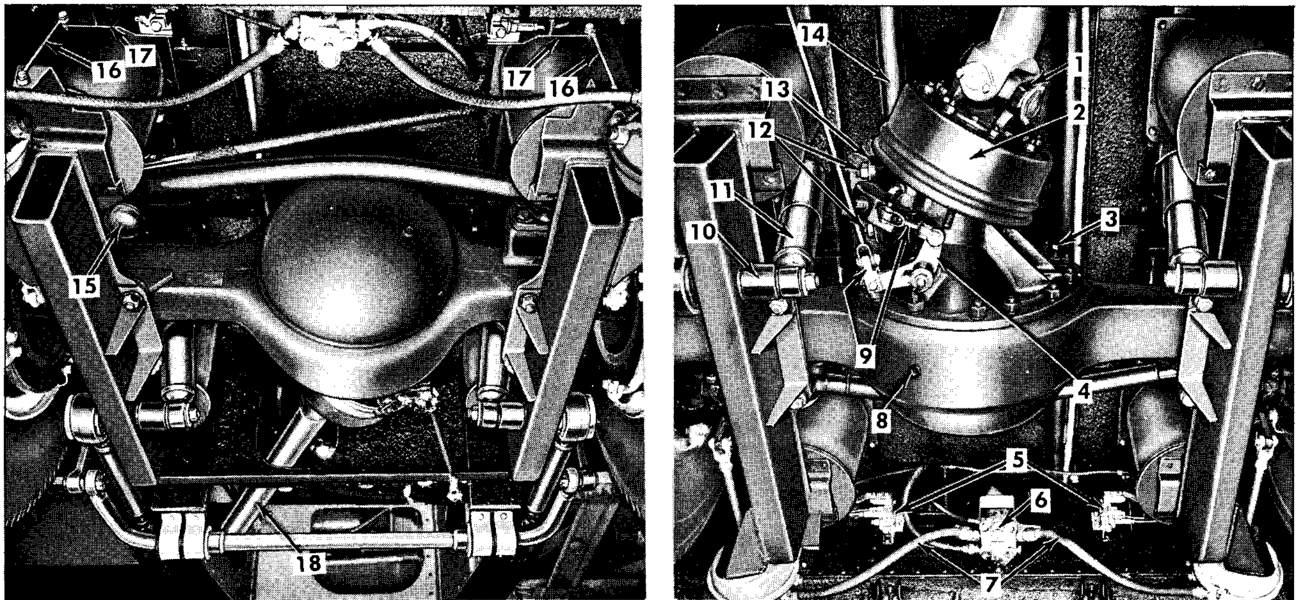


Figure 2—Clearance Between Nut And Flange



FRONT VIEW

REAR VIEW

1 Flange Yoke
2 Hand Brake Drum
3 Puller Screw
4 Bell Crank
5 Height Control Valve
6 Brake Relay Valve
7 Brake Chamber Hose
8 Drain Plug
9 Brake Linkage
10 Mounting Bracket
11 L.H. Shock Absorber
12 Anchor Plate Studs
13 Anchor Plate
14 Upper Radius Rod
15 Axle Bumper
16 Height Control Valve Link
17 Height Control Valve Lever
18 Propeller Shaft

TPM-9266-1

Figure 3—Rear Axle And Air Suspension Installed

3. Dip splined end of axle shaft in rear axle lubricant, then insert shaft into housing, guiding shaft into side gear and at same time align flange holes with hub studs. When studs and flange holes are in alignment, push axle shaft into place.

4. Install split tapered dowels, external toothed lock washers, and nut on four studs at tapered holes in flange (three or four - differs by model), also install lock washers and nuts at remaining four or six studs. Tighten nuts alternately and evenly to 170-210 foot-pounds torque.

5. Observe that clearance exists between nut and flange (fig. 2). If no clearance exists, this indicates excessive wear at studs, dowels, or flange holes. Replace worn parts if necessary.

DIFFERENTIAL CARRIER REPLACEMENT (WITH AXLE IN VEHICLE)

(Key numbers in text refer to figure 3)

REMOVAL

1. Place rear wheels of coach on 10-inch riser blocks, keeping blocks flush with inside of rear wheels. Block front wheels securely, FORE and AFT, to prevent vehicle rolling.

2. Remove both rear axle shafts as instructed under "Axle Shaft Replacement" in this section.

3. Remove drain plug (8) and drain lubricant from the axle housing.

4. Disconnect the propeller shaft (18) at the flange yoke (1), adjacent to the hand brake drum (2), and wire to body understructure to obtain maximum clearance.

5. Place the hand brake lever in released position and disconnect the parking brake control rod linkage (9). Remove bell crank (4) from the differential carrier.

6. On narrow model coaches it will be necessary to remove the left shock absorber (11) from the lower left shock absorber anchor mounting bracket (10). Use a board or wire to hold the shock absorber away from the carrier assembly.

7. Remove the air hoses (7) leading from the rear brake chambers to the brake relay valve (6) to prevent damage to hose when raising body, and disconnect height control valve links (16).

8. Lift up on both height control valve levers (17) to admit air pressure into the rear suspension bellows. Hold levers up until coach body has raised sufficiently to permit installation of safety spacers (approximately 10") between body and axle at each side. The spacers can be made from steel tubing of sufficient diameter to fit over axle bumpers (15).

9. Remove the two anchor plate studs (12) which attach the upper radius rod (14) to the rear

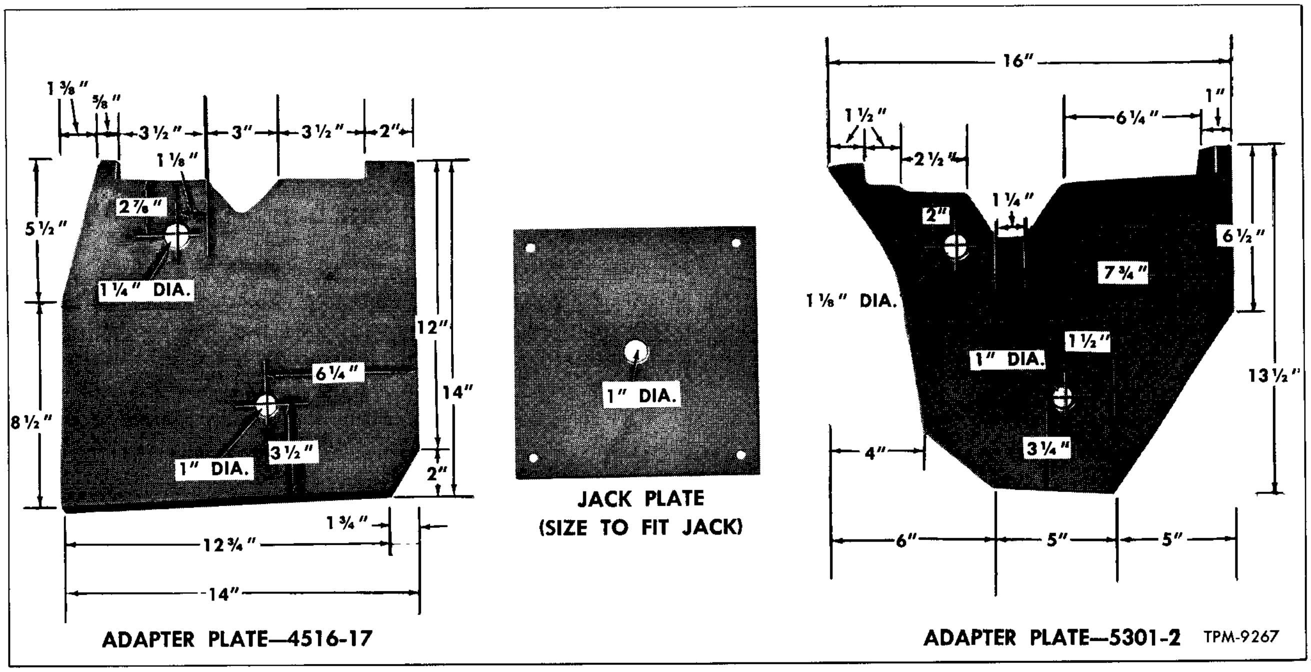


Figure 4—Special Plates For Removing Differential Carrier

axle carrier assembly using a double nut method or a suitable stud puller.

10. Remove the press fit upper radius rod mounting bolt, pry loose, and remove the anchor plate (13).

11. Remove nuts from the differential carrier studs.

12. Remove all studs from the lower half of the axle carrier using a double-nut method or a suitable stud puller.

13. Remove the two puller screws (3) from the carrier assembly and install two 1/2-13 x 3 inch puller screws. Pull carrier assembly to end of studs.

14. A floor model dolly jack, adapted for removing the differential assembly, should be positioned under the coach. An adapter plate should be fabricated locally, using a 3/4-inch flat steel plate and shaped to fit the lower portion of the differential carrier assembly. Two holes must be drilled into this plate. One hole will be used to fasten the slack adjuster bell crank stud to the anchor plate and the second hole will be used to attach the adapter plate to a base plate mounted on the jack.

A second 3/4-inch flat steel plate must be fabricated to fasten to the floor jack and adapter plate to permit rotation of the adapter plate. Refer to figure 4.

15. Pull the carrier assembly back as far as possible. Tilt the gear end of the carrier assembly up until it clears the yoke. As the carrier is moved out of the housing, move it down and to the right to clear all obstructions. (Refer to figure 5, showing carrier removed.)

INSTALLATION

1. Before reinstalling the carrier assembly, clean mating surfaces of carrier flange and axle housing.

2. Back the top stud in axle housing out 1/2-inch to guide the carrier assembly into position.

3. Mount the carrier assembly on the floor jack using the same base plate and adapter plate used to remove the carrier. Use wire or string to secure a new gasket to the carrier flange until the carrier can be positioned in the axle housing.

4. On narrow model coaches it will be necessary to remove the hand brake drum (2) to gain sufficient clearance to reinstall the carrier assembly.

5. With the carrier securely supported on the floor jack, roll under vehicle and maneuver into position at axle housing. Start carrier into housing until studs extend through the carrier flange. Remove wire or string used to attach the gasket to the carrier flange and transfer gasket to the studs of the housing. Use flat washers and nuts on four evenly spaced studs to draw carrier squarely into the housing.

6. Reinstall studs in lower half of the carrier assembly. Seat studs firmly, using a double-nut method or a suitable stud replacer.

7. Remove nuts and flat washers used to draw carrier into position, then install lock washers and nuts on all studs.

8. Remove the two 1/2-13 x 3 inch puller screws used in removing the carrier assembly and install puller screws (3) originally used.

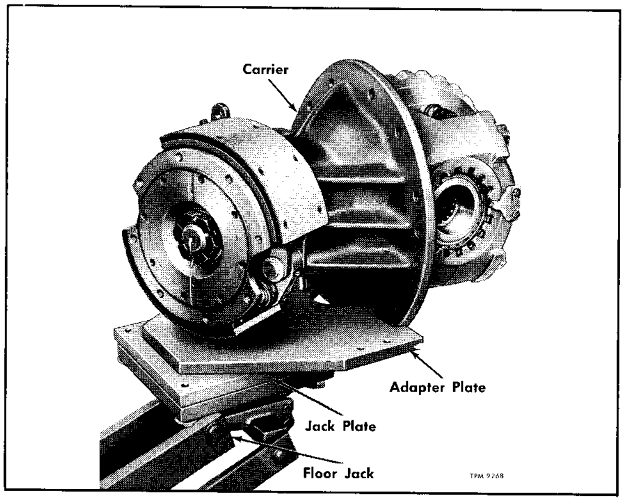


Figure 5—Carrier Assembly Removed

9. Reinstall the hand brake drum (2) if it was previously removed.

10. Reinstall the upper rear radius rod (14) by placing the anchor plate (13) over studs in the carrier. Attach the anchor plate with two anchor plate studs (12) and two anchor plate stud nuts. Position the upper radius rod end and insert the anchor pin and anchor bolt. Install the anchor bolt washer and nut.

11. Remove safety spacers by pushing up on both height control valve levers (17) to admit air pressure into the bellows. When safety spacers have been removed, pull down on both height control valve levers to exhaust air pressure from bellows until normal ride height is achieved. Connect height control valve links (16).

12. Reconnect the air hoses (7) leading from the rear brake chambers to brake relay valve (6).

13. On narrow model coaches it will be necessary to reconnect the left shock absorber (11) to the shock absorber anchor mounting bracket (10).

14. Reinstall the bell crank (4) on the differential carrier and connect the parking brake control rod linkage (9).

15. Reconnect the propeller shaft (18) at the yoke (1), adjacent to the hand brake drum (2).

16. Install drain plug (8) in axle housing and tighten firmly. Fill axle housing with lubricant, and lubricate propeller shaft universal joints and parking brake bell crank (4).

17. Adjust parking brake linkage (9).

18. Install axle shafts.

DISASSEMBLY

The following instructions provide procedures for complete disassembly, cleaning, inspection, repair, and reassembly of rear axle. Axle housing may be checked for bent condition before axle assembly is removed from coach. The following repair procedure is based on the operations necessary when axle is removed from coach.

Before and during disassembly operations, perform following inspections and check all adjustments to determine repairs required.

KEY NUMBERS IN TEXT REFER TO FIGURE 1 UNLESS OTHERWISE INDICATED.

AXLE HOUSING CHECK

At regular inspection intervals, or if conditions indicate that rear axle housing might be bent, housing should be checked, using the following method. This check can be made before or after axle is removed from coach to determine if axle housing is sprung. Conventional camber and toe-in gauges can be used to perform inspection.

1. Support axle in level position using blocks at each support beam; then check rear wheel bearings for proper adjustment as instructed in HUBS, WHEELS, AND TIRES (SEC. 19).

2. Check run-out at each rear wheel and replace wheels having run-out in excess of 3/32".

3. Check for toe-in and camber at rear wheels. Rear wheels should not toe-in or out more than 1/8", and camber should be zero, plus or minus 1/4 degree. If measurements are not within the above dimensions, bent or sprung axle housing is indicated. Make notation of the existing conditions for use when making corrections later.

4. In cases where bent axle housings are indicated, further checks to determine exact location of bend should be made after differential carrier has been removed, then necessary steps taken to correct the condition. Any straightening should be done with axle housing cold; UNDER NO CIRCUMSTANCES SHOULD HEAT BE APPLIED.

DIFFERENTIAL CARRIER REMOVAL

1. Remove axle shafts as previously instructed under "Axle Shaft Replacement" in this section.

2. Remove stud nuts and lock washers attaching parking brake drum to propeller shaft flange, then slide drum rearward over propeller shaft yoke.

3. Remove nuts and bolts attaching propeller shaft yoke to flange, then remove propeller shaft yoke.

4. Remove drain plug and drain lubricant from housing.

5. Remove hand brake control rod from bell crank at differential carrier.

6. Remove stud nuts (40) and lock washers (41) from differential carrier studs (39).

7. Be certain that differential carrier is supported solidly, then proceed to pull complete carrier assembly out of housing. A small pinch bar may be used to keep carrier straight in housing bore while it is being withdrawn, provided end of bar is rounded to prevent damage to carrier flange.

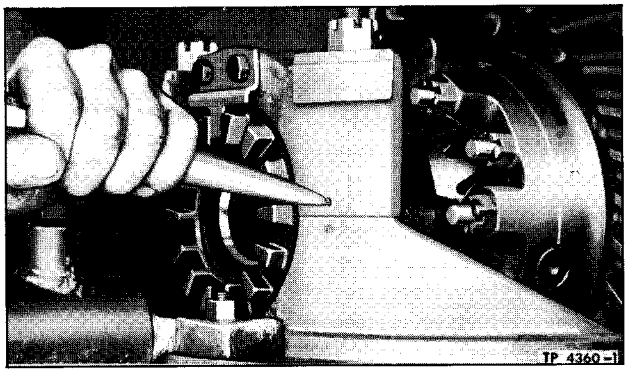


Figure 6—Bearing Cap Alignment Marks

DIFFERENTIAL REMOVAL

1. Remove lock wire from adjusting ring lock retaining bolts (7), then remove locks (6).

2. Remove lock wire and nuts from differential side bearing cap studs. Make certain that bearing caps (45) and carrier are marked (fig. 6) before removal; then remove side bearing caps (45). Remove side bearing adjusting rings (8). Lift differential assembly with cups (44) from carrier.

DIFFERENTIAL DISASSEMBLY

1. Mark both halves of differential case (2) so halves may be reassembled in original positions (fig. 7).

2. Remove side bearings (43) from each half of case, using suitable bearing puller in manner illustrated in figure 8, or drive out as shown in figure 9, using bearing remover plug (J-4856).

3. Remove lock wire and nuts (5) from bolts (48) which hold the two halves of differential case (2) together; then separate halves of case.

4. Remove side gears (13), thrust washers (12), spider (3), pinions (46), and thrust washers (4) from differential case.

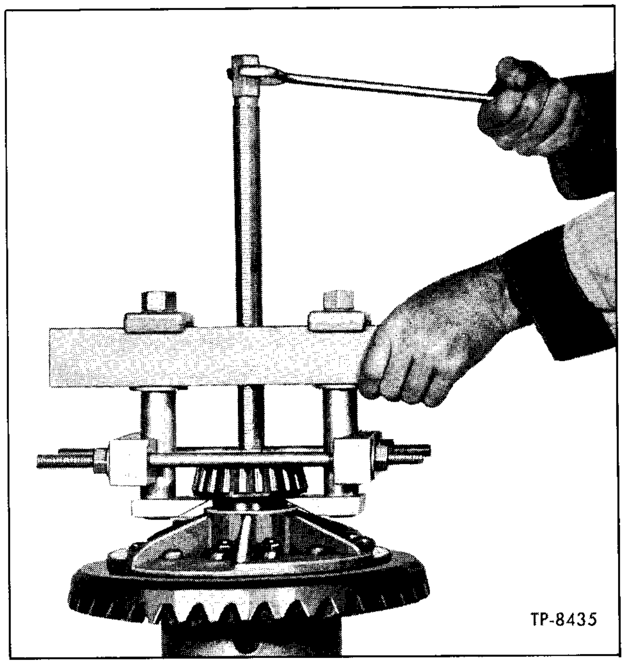


Figure 8—Differential Bearing Removal

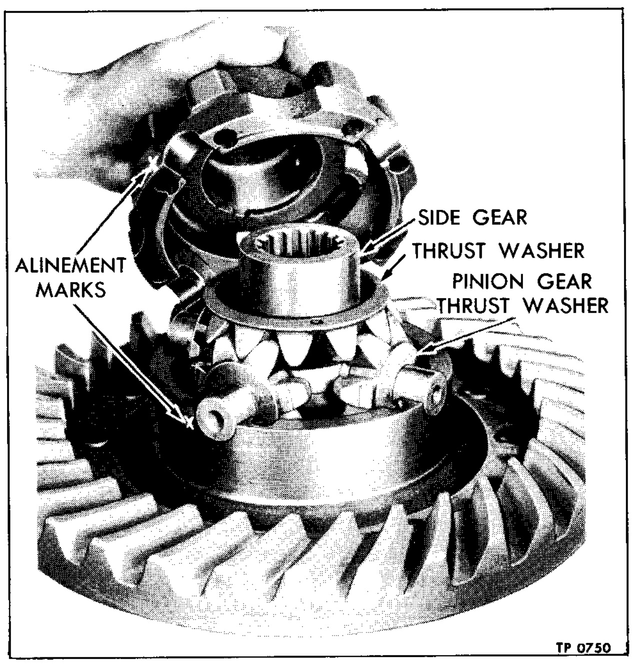


Figure 7—Differential Case Alignment Marks

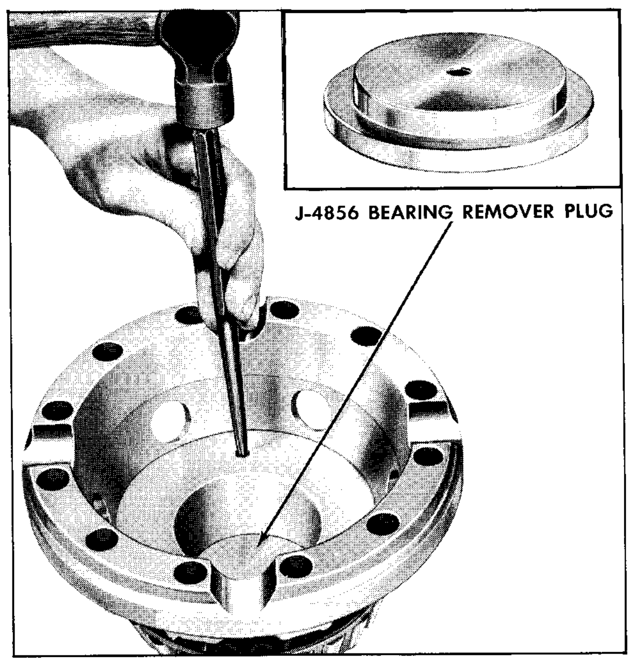


Figure 9—Differential Bearing Removal

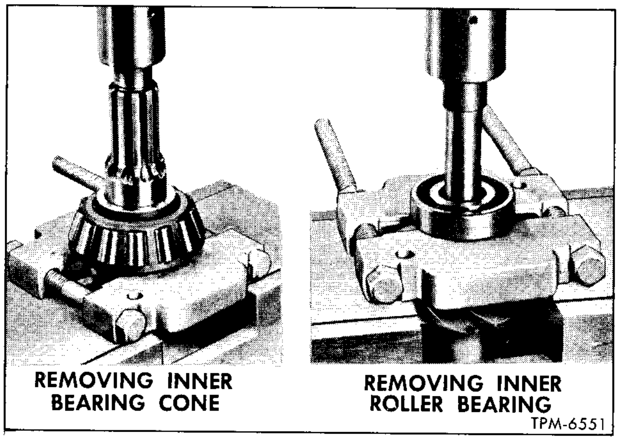


Figure 10—Pinion Bearing Removal

5. If either drive gear (1) or drive pinion (36) are worn or damaged, both must be replaced as a matched set. Never replace drive pinion or drive gear separately.

PINION CAGE REMOVAL AND DISASSEMBLY

1. Remove brake shoe and camshaft as directed in "HAND BRAKE" (SEC. 4).
2. Remove nuts (20) and lock washers (19) which secure pinion cage (30) to differential carrier (16). Tap pinion cage to loosen and remove four tapered dowels (18).

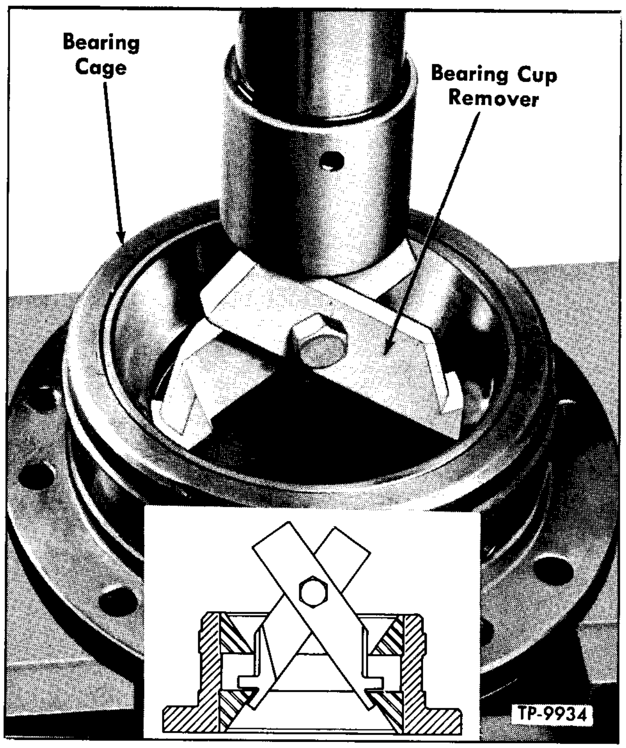


Figure 11—Pinion Cage Bearing Cup Removal

3. Install two puller screws (1/2"-13 x 2-1/2") and tighten alternately and evenly to pull cage (30) out of carrier. Remove shim pack (17) from pinion cage studs (21). Tie shims (17) together so same shim pack may be used at reassembly.
4. Remove retainer ring (38) which secures inner bearing (37) on drive pinion (36); then remove inner bearing from drive pinion using universal puller (J-8176) and arbor press in manner illustrated in figure 10.
5. Clamp pinion in vise equipped with soft jaw plates. Remove cotter pin, nut (25), and washer (26) from drive pinion (36).
6. Place cage and drive pinion assembly in an arbor press and press drive pinion (36) out of flange (27) and pinion cage. Outer bearing (31) will remain in pinion cage (30).
7. Remove cap screws and lock washers attaching oil seal retainer (23) to pinion cage, then remove slinger.
8. Remove bearing adjusting spacer (33) from drive pinion (36) and tag for reassembly reference.
9. If necessary, inner bearing cone (35) can be removed from pinion with universal puller (J-8176) and arbor press as illustrated in figure 10.
10. Remove oil seal (29) assembly from pinion cage.
11. When inspection indicates necessity, cups (32 and 34) can be removed from cage, using remover (J-3940) in manner illustrated in figure 11.

CLEANING, INSPECTION, AND REPAIR

CLEANING BEARINGS

The importance of proper bearing cleaning cannot be over-emphasized. Bearings should always be cleaned separately from other rear axle parts. When cleaning bearings, be sure to perform all of the following steps:

1. Soak differential and drive pinion bearings in clean kerosene, Diesel fuel oil, or other cleaning solvent. Gasoline should not be used as a bearing cleaner. Also, bearings should never be placed in a hot solution tank for cleaning.
2. After old lubricant is loosened, hold bearing races so that bearings cannot rotate, then brush bearings with soft bristled brush until all grit and dirt has been removed.
3. Rinse bearings in clean fluid; then, while holding races, blow dry with compressed air. Be sure air stream is moisture free.
4. Inspect bearings as instructed under "Inspection Operations" later in this section. If bearings pass inspection, dip bearings in differential lubricant recommended in LUBRICATION (SEC. 13); then wrap bearings in clean cloth or paper until ready to reassemble axle.

CLEANING PARTS

Immerse all parts in suitable cleaning fluid and clean parts thoroughly. Use a stiff bristle brush to remove all old lubricant. Remove particles of gaskets which may adhere to mating faces of axle housing, differential carrier, hubs, and axle shaft flanges. Clean out lubricant channels in pinion cage and differential carrier. Clean housing breather. Make certain that interior of axle housing is thoroughly cleaned.

INSPECTION

Whenever available, the Magna Flux method should be used on all steel parts, except ball and roller bearings. This method is especially suited for inspection of ground or highly finished surfaces for wear and cracks which otherwise would not be visible.

INSPECTION OPERATIONS

1. Bearings. Rotate each bearing slowly, and at the same time examine bearing for roughness, damage, defects, or wear. Note condition of bearing cage. Replace bearing if cage is damaged or if any of the conditions previously noted exist.

2. Gears. Examine drive gear, drive pinion, and differential gears for damaged teeth, worn spots in surface hardening, and distortion. Check differential pinions for excessive wear, and fit on spider. Refer to "Specifications" at end of this section for limits. Check radial clearance between differential side gear hubs and differential case.

3. Differential Case. Inspect differential case assembly for cracks, distortion, or damage. If case is in good condition, thoroughly clean case and cover; then assemble case with bolts and mount in lathe centers or "V" block stand. If lathe is not available, install differential side bearings and mount case in differential carrier as directed under "Differential Assembly Installation" later in this section. Install dial indicator and check differential case run-out. Refer to "Specifications" at end of this section, for run-out limits. Whenever run-out exceeds limits, differential case run-out may be corrected as later described under "Repair" in this section.

4. Axle Shafts. Examine splined end of axle shaft for twisted or cracked splines, twisted shaft, or damaged flange. If any of above conditions are evident, install new axle shafts.

5. Axle Shaft and Flange Run-Out. Install axle shaft assembly in lathe centers or "V" blocks. Check shaft run-out with dial indicator; if run-out exceeds limits listed in "Specifications" at end of this section, discard axle shaft. Position dial indicator so that indicator shaft end contacts inner surface of flange near outer edge, then check flange run-out. If run-out exceeds limits listed in "Specifications" at end of this section, discard axle shaft.

AXLE HOUSING INSPECTION

If check made prior to disassembly of axle indicated a bent condition at axle housing, make more complete check of housing on surface plate and after locating point at which housing is bent, the housing may be straightened if equipment is available. Any straightening must be done with axle housing cold, DO NOT APPLY HEAT TO HOUSING.

OIL SEAL INSPECTION

Replacement of oil seal when unit is disassembled is more economical than premature overhaul to replace this part at a future time. Further loss of lubricant through a worn seal may result in failure of other parts, such as gears and bearings.

Handle seal carefully, particularly when being installed. Cutting, scratching, or curling under of lip of seal seriously impairs efficiency of seal. Use of Permatex or equivalent around outer diameter of seal is recommended to insure against leakage at this point.

OIL SEAL SLEEVE

Carefully inspect oil seal sleeve at propeller shaft flange for any pitted, corroded, or worn condition at oil seal contact surface. If such imperfections cannot be cleaned up by polishing, the sleeve must be replaced.

REPAIR

Differential Case. Excessive run-out on differential case may be corrected by machining flange on gear side of case. Remove sufficient metal from flange to correct excessive run-out. Metal must be cut on a true plane, removing just enough metal to bring run-out within limits listed in "Specifications" at end of this section. After differential case has been machined, remove burrs and clean case assembly thoroughly.

Propeller Shaft Flange Sleeve. Whenever inspection indicates that oil seal contact surface of sleeve on propeller shaft flange is corroded or pitted, the condition may be corrected by cleaning and polishing surface with a suitable abrasive cloth. If cleaning and polishing surface of sleeve does not clear up the condition, remove sleeve and install new part.

AXLE ASSEMBLY

After all parts have been thoroughly cleaned, apply a thin coating of differential lubricant, as specified in LUBRICATION (SEC. 13), on all thrust or bearing surfaces. Coating parts will prevent scoring when vehicle is first placed in service.

Use of new lock washers, gaskets, and oil seals is recommended during assembly of axle.

REAR AXLE

All adjustments given in assembly procedures must be made carefully to insure efficient and continuous axle operation.

KEY NUMBERS IN TEXT REFER TO FIGURE 1 UNLESS OTHERWISE INDICATED.

DRIVE PINION AND CAGE ASSEMBLY

1. If pinion bearing cups (32 and 34) were removed during disassembly, press bearing cups firmly against shoulder of pinion bearing cage.
2. Position pinion bearing (35) on drive pinion (36), with widest part of bearing cone toward gear teeth, then press bearing on pinion until bearing cone is seated solidly on drive pinion.
3. Install drive pinion inner bearing (37) on drive pinion (36), using arbor press. Install retainer ring (38) to retain bearing.
4. Lubricate pinion bearing cones and cups with light engine oil. Install original pinion bearing adjusting spacer (33) on drive pinion.
5. Insert drive pinion (36) and bearing assembly into pinion cage (30); then, using an arbor press, press outer pinion bearing (31) firmly against bearing spacer (33). Rotate bearing cage through several complete revolutions to assure normal bearing contact.
6. While assembly is still in press under pressure (14-ton), check drive pinion bearing preload. Wrap soft wire around pinion bearing cage (30) as shown in figure 12. Attach pound scale to wire, then pull on scale, keeping scale in a horizontal plane. Note scale reading when assembly is rotating freely. Reading should be from 5 to 15 inch-pounds. To compute inch-pound value of scale reading, multiply scale reading (pounds) by one-half pinion cage diameter (inches). If reading does not fall between limits given, use thinner spacer (33) to increase or thicker spacer to decrease pinion bearing preload. Spacer thicknesses available are given in "Specifications" at end of this section.

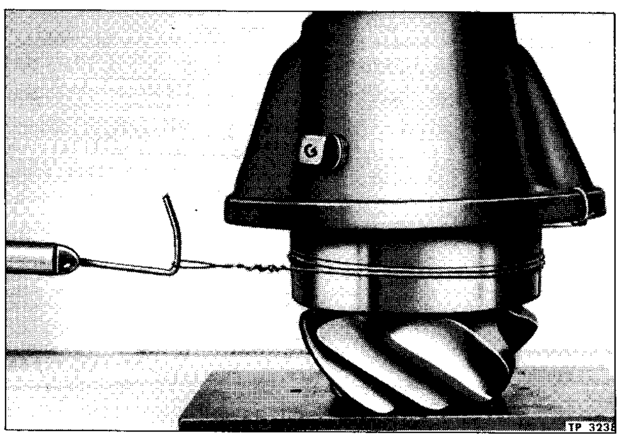


Figure 12—Checking Pinion Bearing Pre-Load

NOTE: If arbor press is not available, temporarily install propeller shaft flange (27), washer (26), and nut (25). Tighten nut to 800-1100 foot-pounds torque, then check pinion bearing preload as directed in preceding paragraph. Remove nut, washer, and flange after adjustment.

7. Lubricate oil seal assembly (29) and cover outer edge of seal body with a non-hardening sealing compound; then install oil seal in cage, being careful that it is straight and is seated against shoulder in cage. Install oil seal sleeve (24).
8. Install oil seal retainer (23) to cage, using new gasket. Install and tighten cap screws to 33-37 foot-pounds torque.
9. Install dust slinger (28) and propeller shaft flange (27).
10. Place washer (26) on drive pinion (36), then install nut (25). Tighten nut to minimum torque of 800 foot-pounds, then tighten nut until next castellation on nut lines up with cotter pin hole in drive pinion and install cotter pin.

DRIVE PINION INSTALLATION

1. Lubricate drive pinion bearings with rear axle lubricant recommended in LUBRICATION (SEC. 13).
2. Place original pinion cage shims (17) over pinion cage studs (21), then position drive pinion and cage assembly on studs (21). IMPORTANT: Oil holes in shims must line up with oil passages in differential carrier and cage when installed, to assure proper lubrication of drive pinion bearings (31 and 35).
3. Install split tapered dowels (18), external toothed lock washers, and nuts at four studs, also lock washer and nut (20) at four remaining studs. Tighten nuts (20) to 80-90 foot-pounds torque.

DIFFERENTIAL ASSEMBLY

After checking differential case run-out as previously described under "Cleaning, Inspection, and Repair" in this section, assemble differential as follows:

1. Lubricate differential case inner walls and all component parts of differential assembly with rear axle lubricant specified in LUBRICATION (SEC. 13).
2. Position side gear thrust washer (12) on hub of side gear (13), then place gear in flanged half of differential case (2).
3. Lay flanged half of case on bench with flange upward, place differential pinions (46) and pinion thrust washers (4) on differential spider (3), place pinion and spider assembly on side gear (13) previously installed, then install remaining side gear (13) and thrust washer (12).
4. Place plain half of differential case on opposite half, with alignment marks positioned as

shown in figure 7. Install case bolts (47) downward through both halves of case.

5. Install nuts (5) on four equally spaced bolts (47), and tighten to torque of 185-205 foot-pounds. Check assembly for free rotation. If rotation is free and smooth, install remaining bolts and nuts and tighten to recommended torque.

6. Position drive gear (1) on flanged half of differential case (2), with alignment marks, stamped on plain case and drive gear, opposite each other. Install and tighten bolts (15) to 290-320 foot-pounds torque. Install lock wire (14) through bolt heads in such a manner that lock wire will become tighter if bolts should become loose.

7. Press differential side bearings (43) on hubs of differential case (2), until bearing cones seat firmly.

DIFFERENTIAL ASSEMBLY INSTALLATION

Proper bearing cup and adjusting ring fit is of utmost importance and should be carefully checked before differential is installed.

1. Temporarily install bearing cup (44), adjuster ring (8), and bearing cap (45), then tighten stud nuts to recommended torque.

2. Bearing cup must be a hand push fit (fig. 13) in bore, otherwise the bore must be reworked with a scraper or emery cloth until proper fit is obtained. Location of high spots in carrier bore can be readily located by applying a light coating of prussian blue to bearing cup.

3. If adjusting ring cannot be turned by hand or with a maximum of 20 foot-pounds torque, this indicates that ring may be oversize and another ring that provides proper fit should be used.

4. Coat differential side bearing cones (43) and cups (44) with rear axle lubricant specified in LUBRICATION (SEC. 13).

5. Place bearing cups (44) over bearing cones (43), then position differential assembly in differential carrier.

6. Insert bearing adjusting rings (8) and turn hand tight against bearing cups (44).

7. Place differential bearing caps (45) over studs with alignment marks in line (fig. 6), then tap lightly into position.

CAUTION: If bearing caps do not seat easily and properly, adjusting rings may be cross-threaded. Remove bearing caps and reposition adjusting rings. Forcing caps into position will result in irreparable damage to differential carrier or to bearing caps.

8. Install nuts on bearing cap studs, tighten nuts to 375-415 foot-pounds torque.

9. Tighten adjusting rings (8) alternately until tight. Revolve differential assembly after each tightening to assure normal bearing contact and to keep bearing cups straight in bores.

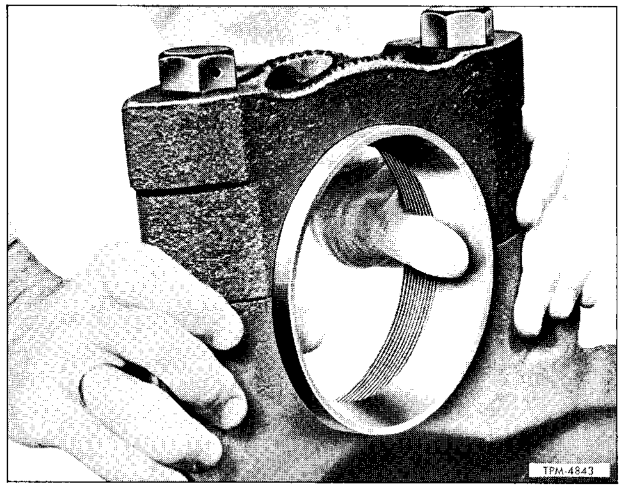


Figure 13—Checking Fit Of Differential Bearing Cup

DIFFERENTIAL BEARING PRELOAD ADJUSTMENT

1. Using dial indicator at back face of drive gear (1) as shown in figure 14, loosen bearing adjusting ring (8), on flanged side, enough to notice end play on dial indicator.

2. Tighten the same adjusting ring until 0.000" end play is obtained.

3. Tighten both adjusting rings (8) one notch each from 0.000" end play position to impose correct preload on differential side bearings.

NOTE: After adjusting bearing preload, proceed with tooth contact and backlash adjustment as directed in following paragraph.

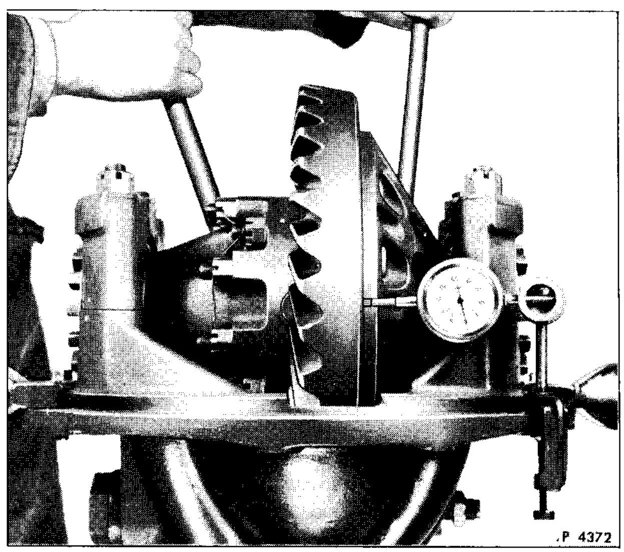


Figure 14—Differential Bearing Pre-Load Check

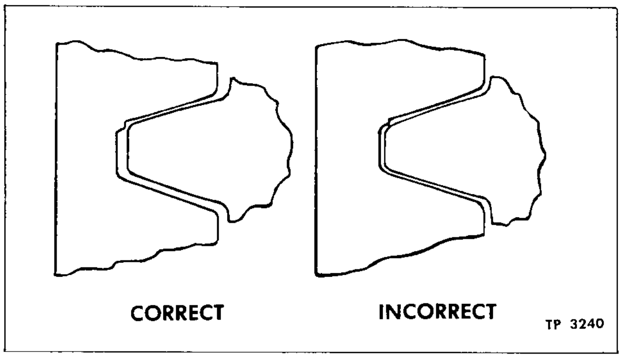


Figure 15—Worn Tooth Cross Section

GEAR TOOTH CONTACT ADJUSTMENT

Drive pinion (36) is adjusted for tooth contact by means of shims (17) between pinion cage (30) and differential carrier (16). Drive gear (1) is adjusted by means of adjusting rings (8).

If original gears are reinstalled in assembly, painting gear teeth will not indicate the same contact as new gears and can be misleading. Gears that have been in service for extensive periods, form running contacts due to wear on teeth. Therefore, the original shim pack (17) plus one 0.005" shim should be maintained to check backlash.

In the event that backlash exceeds maximum tolerances, reduce backlash only in the amount that will avoid overlap of worn teeth (fig. 15).

When new gears are to be installed, differential bearings and drive pinion bearings must be in proper adjustment before any attempt is made to adjust backlash. Check backlash with dial indicator as shown in figure 16, and adjust to obtain 0.006"-0.012" lash. Adjust backlash and tooth contact in the following manner:

1. Paint at least ten teeth of bevel gear with a mixture of red lead or prussian blue and engine oil. Rotate gears through a few revolutions in both directions by hand. Refer to gear tooth contact charts (fig. 17), for directions for making proper adjustments.

2. When satisfactory tooth contact and backlash has been obtained, install adjusting ring locks (6) and secure bolts (7) with lock wire.

DIFFERENTIAL CARRIER INSTALLATION (WITH AXLE OUT OF VEHICLE)

1. Clean flanges of differential carrier (16) and axle housing (10), then position new differential carrier gasket (11) on carrier studs (39).

2. Roll differential carrier assembly into position using roller jack (or comparable type support). Start carrier into housing using four flat

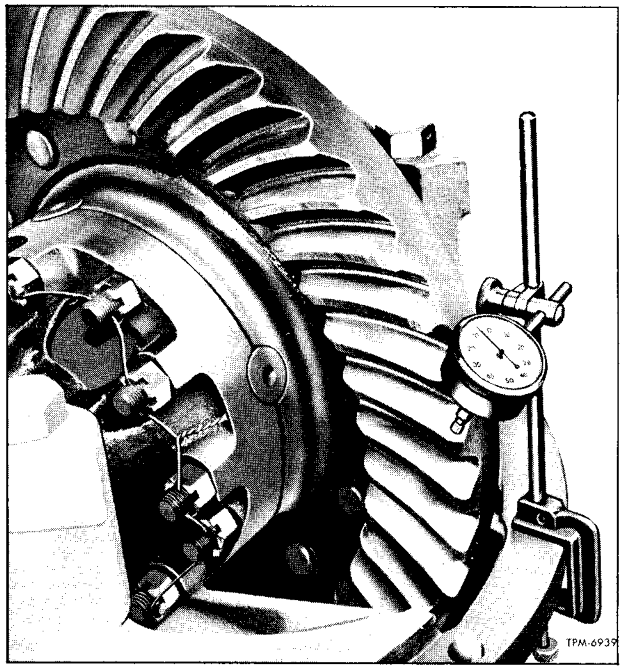


Figure 16—Gear Backlash Check

washers and nuts (40) equally spaced, then tighten nuts alternately and evenly to draw carrier squarely into housing.

CAUTION: Driving carrier into axle housing by use of a steel hammer will not only damage carrier stud flange but will also cause oil leaks.

3. Remove nuts and flat washers, then install lock washers (41) and stud nuts (40). Tighten nuts to 290-320 foot-pounds torque.

4. Install brake camshaft and brake shoes as directed in "HAND BRAKES" (SEC. 4).

5. Install brake drum and propeller shaft yoke.

6. Adjust hand brake as instructed in "HAND BRAKES" (SEC. 4).

7. Install drain plug and tighten firmly. Fill axle housing to proper level with lubricant specified in LUBRICATION (SEC. 13). Install and tighten filler plug.

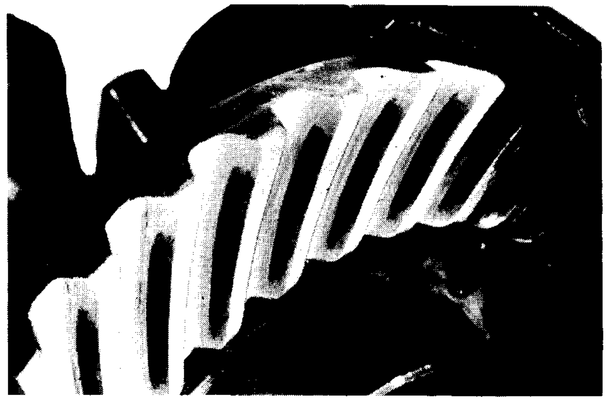
COMPLETING ASSEMBLY

1. Before installing axle shafts, hubs should be removed, and bearings cleaned, inspected, and adjusted as directed in HUBS, WHEELS, AND TIRES (SEC. 19).

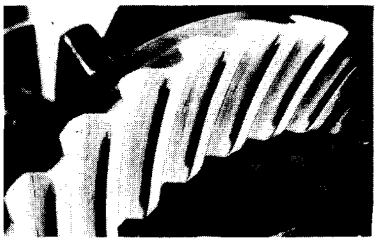
2. Install axle shafts as directed previously under "Axle Shaft Replacement" in this section.

3. Complete instructions for installation of rear axle assembly will be found in AIR SUSPENSION (SEC. 14).

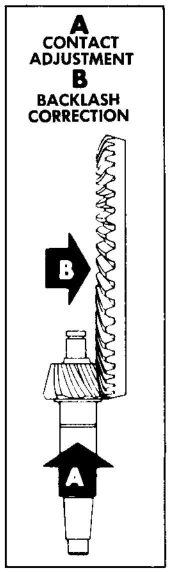
PAINTING GEAR TEETH



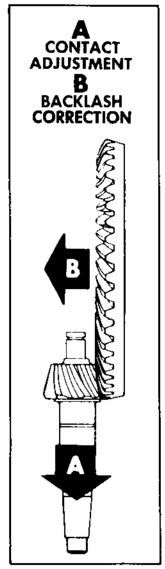
CORRECT TYPE TOOTH CONTACT

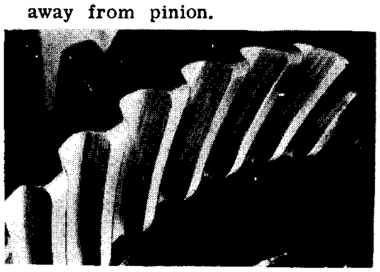


A HIGH NARROW CONTACT is not desirable. If gears are permitted to operate with an adjustment of this kind, noise, galling and rolling over of top edge of teeth will result. To obtain correct contact, move pinion toward bevel gear. This lowers contact area to proper location. This adjustment will decrease the backlash which may be corrected by moving bevel gear away from pinion.

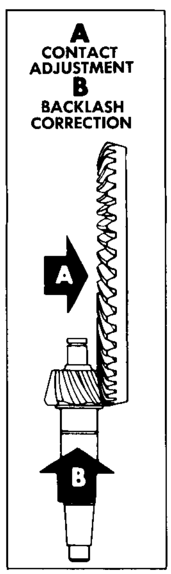


A LOW NARROW CONTACT is not desirable. If gears are permitted to operate with an adjustment of this type, galling, noise and grooving of teeth will result. To obtain correct contact, move pinion away from drive gear. This will raise contact area to proper location. A correct backlash is obtained by moving bevel gear toward pinion.





A SHORT TOE CONTACT is not desirable. If gears are permitted to operate with an adjustment of this type, chipping at tooth edges and excessive wear due to small contact area will result. To obtain correct contact, move drive gear from pinion. This will increase the lengthwise contact and move contact toward heel of tooth. Correct backlash is obtained by moving pinion toward bevel gear.



A SHORT HEEL CONTACT is not desirable. If gears are permitted to operate with an adjustment of this type, chipping, excessive wear and noise will result. To obtain correct contact, move drive gear toward pinion to increase lengthwise contact and move contact toward toe. A correct backlash is obtained by moving pinion away from drive gear.

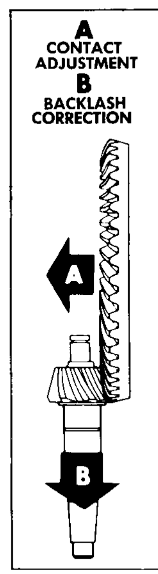


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Figure 17—Tooth Contact Chart

SPECIFICATIONS

TYPE . . . Angle Spiral Bevel

DRIVE . . . Radius Rods

RATIO

SDH-4501	4-5/7 to 1	SDH-5301	5-1/7 to 1
SDM-4501	4-1/8 to 1	SDM-5301	4-1/9 to 1
TDH-4516	4-5/7 to 1	TDH-5301	5-1/7 to 1
TDH-4517	4-5/7 to 1	TDM-5301	4-1/9 to 1
TDM-4517	4-1/8 to 1	TDH-5302	5-1/7 to 1
		TDM-5302	4-1/9 to 1

ADJUSTMENTS AND CLEARANCES
Drive Gear and Pinion Backlash . . . 0.006"-0.012"
Adjustment Method . . . See Text
Shim Thickness (Carrier to Cage) . . . 0.003"-0.005"-0.010"-0.020"

Pinion Bearings
Adjustment Method . . . Selective Spacers
Spacer Thickness . . . 0.187"-0.188"-0.190"-0.192"-0.194"-0.196"-0.198"-0.200"-0.201"-0.215"-0.229"
Rotating Torque (In. Lbs.) . . . 5-15

Differential Bearings
Adjustment Method . . . Threaded Adjusting Rings
Bearing Pre-Load . . . See Text

DIFFERENTIAL CASE
Run-Out (Max.) . . . 0.003"

SPIDER PINION
Bore Diameter (Grind) . . . 1.252"-1.254"
Clearance—Pinion to Spider . . . 0.004"-0.008"

SPIDER
Diameter of Arms . . . 1.246"-1.248"
Arms in Same Plane Within . . . 0.0025"

THRUST WASHER THICKNESS
Side Gear . . . 0.121"-0.125"
Spider Pinion . . . 0.058"-0.062"

AXLE SHAFT
Type . . . Full Floating
Drive Flange Run-Out (Max.) . . . 0.005"
Shaft Run-Out at Center (Max.) . . . 1/16"
Diameter at Splined End . . . 2.372"-2.377"

TORQUE SPECIFICATIONS (Ft. Lbs.)
Propeller Shaft Flange Nut . . . 800-1100
Pinion Cage Stud Nuts . . . 80-90
Carrier to Housing Stud Nuts . . . 290-320
Differential Case Bolt Nuts . . . 185-205
Differential Bearing Cap Stud Nuts . . . 375-415
Bevel Gear Cap Screw . . . 290-320
Adjusting Ring Lock Cap Screw . . . 15-20
Axle Shaft Flange Stud Nut . . . 170-210

Body

This group is divided into three sections covering "GENERAL BODY MAINTENANCE," "DOORS AND CONTROLS," and "HEATING AND VENTILATION."

General Body Maintenance

GENERAL MAINTENANCE

Unlike the conventional motor vehicles which have separate frame the coach body comprises the main structure of the vehicle. Body construction is basically aluminum, reinforced with steel components. Chassis units such as the power plant, axles and steering system, etc., are attached directly to the body.

The body framing and outer panels are constructed into a box-type unit which absorbs all the road shock, driving and braking stresses. A small amount of twist occurs in body, as complete rigidity of the structure is not desirable. It is, therefore, important that body be regularly inspected for loose rivets and bolts.

Entire vehicle should be regularly inspected for condition of paint and for corrosion damage, with particular attention given to underside. Inspection should be made more frequently in freezing weather due to the corrosive effect of road deicing materials (salt, calcium chloride, etc.) on metal. If inspection discloses any evidences of corrosion, paint failure, or bare metal, corrective measures as outlined under "Painting" (later in this section) should be immediately employed.

If fiberglass parts, such as the stop and tail lamp panels become damaged, they can be readily repaired as explained later under "Repair of Fiber Glass Parts."

EXTERIOR MAINTENANCE

Body painted surfaces and polished side moldings should be protected by a coating of wax, applied at regular intervals. Periods between applications should be sufficiently short to assure continuous protection of the finish. Any good body wax can be used for both painted and polished surfaces. Wax should be applied immediately after coach has been cleaned.

When necessary to remove previous wax coating, gasoline or similar solvents meeting local fire and health regulations may be employed.

Hard, anodized finish on side moldings is produced by an electrochemical process. Anodic coating is abrasion-resistant and may be cleaned, if necessary, with a mild abrasive cleaner. However, this finish, like other aluminum, is attacked by many acids and most alkalies. Consequently, considerable care should be taken in the selection of chemical cleaners. Do not use an alkaline cleaner.

PAINTING

Aluminum corrodes just as iron and steel rusts. Under certain conditions aluminum will corrode more rapidly than steel. Inspect body surfaces regularly for corrosion and paint condition.

REPAINTING ALUMINUM PARTS

1. Thorough cleaning is essential: All corrosion, grease and other foreign matter must be removed. Solvent cleaning, pressure steam cleaning, wire brushing, and hand sanding methods are recommended.

2. Completely remove old paint by use of organic solvents. Do not use alkaline paint remover on aluminum. If old primer is very difficult to remove and there is no evidence of metal corrosion, old primer may be left on, but all loose paint must be removed.

3. Apply a coat of pre-primer (sometimes called wash-primer), preferably by spraying to a uniform and complete coverage coat on all surfaces. This type primer uses a special accelerating agent containing phosphoric acid which produces an excellent bond to metal. AP-10 made by United Chromium, Inc., and XE-5220 made by Bakelite Corporation, or any equivalent material made by a reputable paint manufacturer should be acceptable. These materials must be used within a few hours after addition of accelerator, therefore, directions of manufacturer should be observed carefully. In lieu of a pre-primer, apply warm 5% sodium dichromate or potassium dichromate solution (two ounces dichromate in one quart of water) to cleaned surfaces. Apply by spraying. Allow parts to dry.

4. Use a zinc chromate primer such as DuPont 63-1016 or Arco 214-30089, or any equivalent material made by a reputable manufacturer.

Apply primer, preferably by spraying, in a very thin coat. If zinc chromate primer cannot be obtained, use of a red oxide primer is recommended, but only as an emergency measure.

5. Apply finish coats:

a. For understructure and other parts not requiring color, apply two coats of the following, or equivalent; Reduce five parts of DuPont RC-147 clear Dulux with one part Duco #3637 Thinner. To each gallon add two pounds Albron (aluminum) paste, stirring mixture thoroughly.

b. If synthetic aluminum enamel is not available, any synthetic or other enamel, aluminum lacquer, or other lacquer, in that order, may be used; but only materials made by a reputable manufacturer should be employed. Then apply one heavy coat of asphalt-base sheet metal deadener approximately 1/32" thick, special spray equipment, including pressure tank, must be used if deadener is applied by spraying.

c. To exposed body parts, apply air-drying surfacer and color coats in accordance with standard practice.

REPAINTING STEEL PARTS

The foregoing procedures may also be applied to steel and iron parts, with following exceptions:

1. Apply a coat of pre-primer (sometimes called wash-primer), preferably by spraying to a uniform and complete coverage coat on all surfaces. This type primer uses a special accelerating agent containing phosphoric acid which produces an excellent bond to metal. AP-10 made by United Chromium, Inc., and XE-5220 made by Bakelite Corporation, or any equivalent material made by a reputable paint manufacturer should be acceptable. These materials must be used within a few hours after addition of accelerator therefore, directions of manufacturer should be observed carefully. Use of phosphoric-base metal conditioner, such as "Metalprep" (Neilson Chemical Co.) or "Deoxidine" (American Chemical Paint Co.) is also recommended in preparing steel for painting. These materials vary in method of application and use, and should be employed only as directed by the manufacturer.

2. Both organic and alkaline paint removers may be used on steel parts. However, if alkaline removers are used, all traces of alkali must be washed off before primer is applied.

3. Oxide-type primer is recommended for use on steel parts, instead of zinc chromate primer.

PAINTING NEW ALUMINUM PARTS

When installing new aluminum parts, or new parts which contact with aluminum parts in assembly, succeeding procedures should be followed:

1. Remove old parts to be replaced.

2. Treat all exposed sides of adjacent parts remaining in body according to previous instructions in steps 1, 2, 3, and 4 under "Repainting Aluminum Parts," if aluminum; if steel, treat as in steps 1, 2, and 3 under "Repainting Steel Parts." Apply finish coat per step 5a under "Repainting Aluminum Parts" to all surfaces both steel and aluminum.

3. Prime coat all sides of new parts to be installed as outlined in step 4 of "Repainting Aluminum Parts," and step 3 of "Repainting Steel Parts"; then apply finish coat as in step 5a. under "Repainting Aluminum Parts" to all surfaces both steel and aluminum.

4. Use only zinc or cadmium coated bolts, washers, and nuts. Dip all bolts, nuts, washers, and rivets in primer and allow to dry.

5. Install new parts, then apply finish coats as outlined in step 5 of "Repainting Aluminum Parts."

PAINTING NEW STEEL PARTS

The above procedures may be applied to new steel and iron parts except that oxide base primers are recommended in place of zinc chromate type.

REPAIR AND REPLACEMENT OF STEEL OR ALUMINUM PARTS

GENERAL

Body and underframe can be repaired and replaced by competent craftsmen with proper tools and equipment.

In the event of serious collision damage, the Coach Technical Service Department of GMC Truck and Coach Division will furnish data, sketches, and other information upon request. Reply will be expedited by specific description of damage, and particularly if photographs are furnished.

REPLACING BODY PARTS

Whenever repairing or replacing aluminum parts, carefully follow accepted and recommended practices. The Aluminum Company of America will furnish, upon request, booklets titled "Riveting Alcoa Aluminum" and "Welding and Brazing Alcoa Aluminum." The booklets explain detailed procedures necessary in repair and replacement of aluminum parts.

Proper precautions must be observed, particularly with reference to welding, reinforcing, corrosion prevention, and replacement, as follows:

1. Welding of aluminum structural members, or any aluminum parts subject to strain or compression, is not recommended. To maintain proper body strength, replace damaged posts, and other structural members with new parts obtained from the factory.

2. To prevent galvanic corrosion of aluminum, all surfaces of dissimilar metals in contact with aluminum must be properly coated with paint and or plating. This also applies to attaching parts such as bolts, washers, nuts, and rivets. Refer to "Repainting Aluminum Parts" and "Painting New

Aluminum Parts," earlier in this secton.

CAUTION: Avoid mixing steel and aluminum structures or parts when making repairs. Do not substitute steel for aluminum in coach structure. Steel can be used for support fittings for separate units, such as air tanks, control rods, etc. Greater deflection of aluminum causes steel parts to tend to take entire load when used in combination with aluminum parts.

STRAIGHTENING

Use of heat when straightening structural parts of body is not recommended, since heat affects structural characteristics of certain alloys and especially heat-treated parts. All body structural members should be straightened cold; any part bent or buckled sufficiently to show strains or cracks after straightening should be replaced, or properly reinforced.

CUTTING

When cutting a structural member, cut at an angle of 30 degrees. Thus, actual length of cut is twice width of piece being cut, and stress or load is distributed over a longer joint when welded. Cutting can be done by torch, although use of saw is preferred, since cut is cleaner and less material is removed.

REINFORCING

CAUTION: Before reinforcing any part of vehicle, determine cause of failure. Body and frame are integral; therefore, driving stresses and strains are transmitted throughout body. Reinforcing a point of apparent failure without correcting underlying cause of failure, may transfer stress to other parts not engineered for such stress, with resultant development of new failures. Since body is designed to "weave" a rigid reinforcement in any part of body may nullify the design of entire vehicle.

Reinforcements can be made of flat, angle or channel stock, whichever is most suitable for purpose. Use of angle reinforcements is recommended due to difficulty in fitting channel reinforcements. Reinforcements should be sufficiently long to distribute load evenly over a considerable area and thickness should not exceed that of member being reinforced. Reinforcements should be riveted to broken parts.

RIVETING

Cold aluminum rivets should be used in aluminum parts.

Diameter of rivets should be approximately 100% thickness of plates to be riveted, although rivet diameter is also dependent upon spacing and number used.

Replacement of body parts will necessitate removal of rivets in many cases. Rivets can be removed readily by cutting off rivet head with a sharp chisel, marking center of rivet with a center punch, then drilling out rivet with a drill slightly smaller than body of rivet. Rivet can also be driven out with punch, instead of being drilled out, depending upon type and size of material riveted. If rivet is large, first cut a groove across center of rivet head with a cape chisel before cutting off head with a flat chisel.

WELDING

Refer to Step 1 under "Replacing Body Parts," regarding welding of structural parts.

Inert arc welding is recommended as heat of weld is localized and burning of material minimized with this method. When welding a cut member, fill or weld cut completely. Welding rods should be of substantially same material as parts to be welded.

SEALING

When replacing front, side, rear panels, and particularly roof panels, special attention should be given to sealing of joints with sealing and caulking compounds.

REPAIR OF FIBERGLASS PARTS

Repair procedure of fiberglass parts are simple and the paint refinishing procedure is the same as recommended previously for metal parts.

In general, all repairs to fiberglass parts consist of filling the damaged area with fiberglass cloth and resin or chopped fiberglass and resin. The repair is allowed to harden and then the finishing operations are performed. Use of the various materials is determined by the type of repair to be made. Such repairs as large holes, torn sections, and separated joints require the adhesive qualities of the resin and the reinforcing qualities of the fiberglass sheets. Small dents, scratches, or pits can be repaired using resin and chopped fiberglass (roving) and filler mixed into a paste. Instructions for use of either mix are explained later under respective headings.

For best results the ambient temperature should be approximately 70° to 75°F., when making repairs.

Some people experience a skin reaction to resins when making repairs. When, and if, this happens, wipe off the skin with denatured alcohol or a good thinner. There are several protective hand creams on the market which can be applied to protect the hands. Use of this cream is recommended.

If any quantity of disc grinding or sanding is to be done in an enclosed area, a respirator should be used. Goggles should also be worn whenever grinding or sanding.

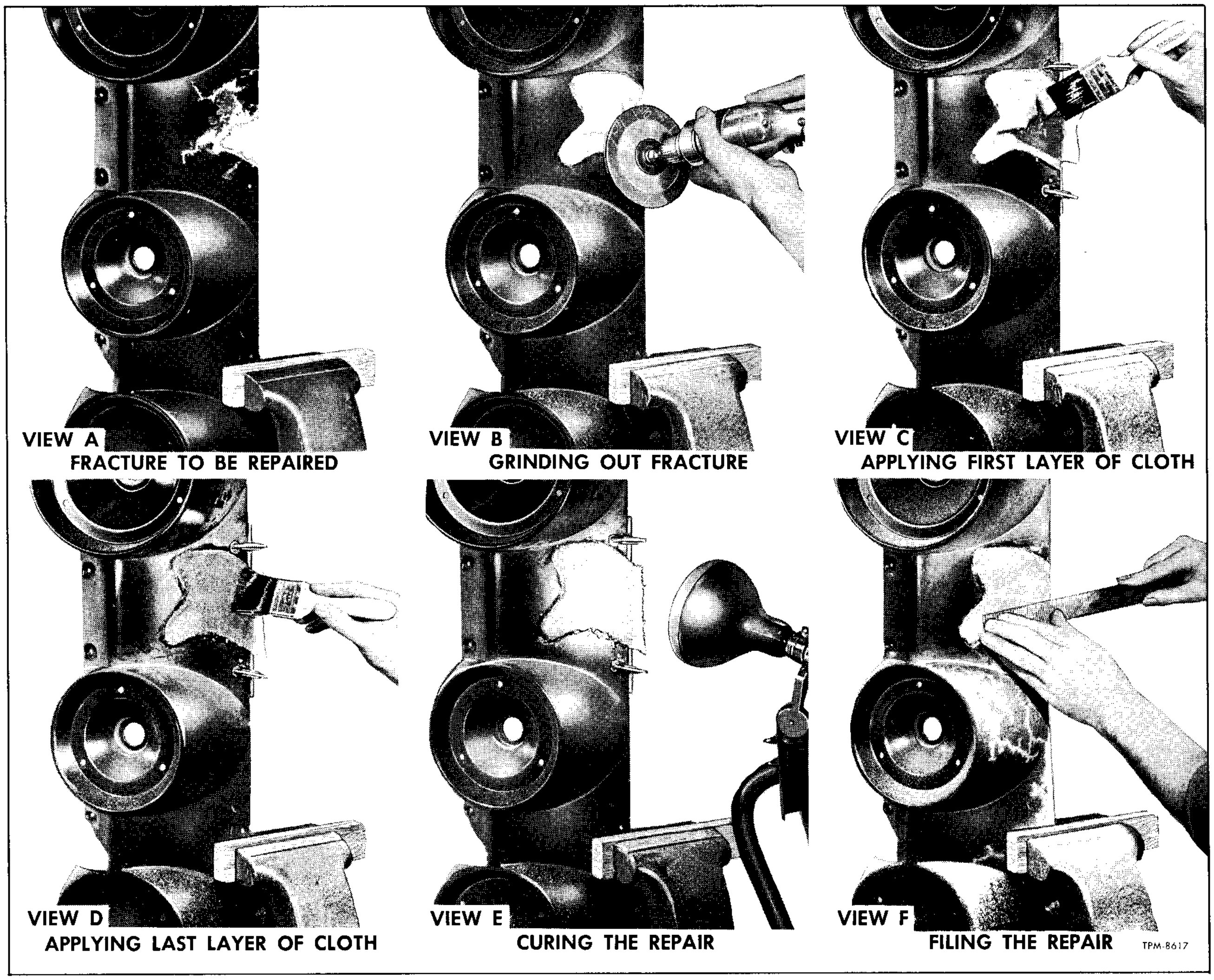


Figure 1—Fiber Glass Repair Views (Typical)

Extreme care must be used if the sander is electrically driven as dust of some resins is combustible when subject to sparks or open flame. The proper tool for sanding resin is a low speed, air driven disc sander with a water attachment or a dry sander having a vacuum bag attachment. Either type sander will serve to eliminate flying glass and resin dust.

The following additional tools and materials will assist in making repairs: Hacksaw blade, assorted files, emery paper or cloth (No. 150 grit or finer), scissors or tin snips, wax paper or cellophane sheets, wallpaper type seam roller, paint brush, putty knife, lacquer thinner, and one or more heat lamps.

Use the right fiberglass materials for the job. When making a repair, use GM Resin Repair Kit - No. 2233617 or equivalent. GM Resin Repair Kit includes fiberglass sheets, roving, and filler material, also resin, hardener, mixing cup, spoons and an instruction sheet. The fiberglass roving and filler mixed in with the resin and hardener will form a paste which can be used for making small repairs.

The following is the recommended procedure for making repairs using GM Resin Repair Kit.

REPAIR PROCEDURE USING FIBERGLASS CLOTH

1. Examine the repair area for hidden damage. Apply pressure by hand around the area. View A, figure 1 shows a fractured stop and taillight moulding.

2. Use paint remover and remove finish from around damage area. NOTE: Do not allow remover fluid to run onto area not requiring repair. Inspect area again for signs of other damage.

3. Grind or file the damaged area to form a "V" at the broken or cracked portion (View B, fig. 1). Side of "V" should have a shallow pitch for

maximum bonding surface. NOTE: Roughening the surface improves adhesion of resin.

4. If back side of damage is accessible, use a button-type repair whereby the rear side of break or crack is also repaired. Clean back side to permit use of laminate (resin-saturated glass cloth) on both sides of damaged area.

5. If part is warped from original shape, use "C" clamps and improvised clamp plates to align surfaces (View C, fig. 1).

6. Preheat area to be repaired using one or two heat lamps positioned 12 to 15 inches from repair.

CAUTION: 250°F. to 275°F., is the high limit for this material and to go higher is to risk material distortion or crystalizing.

7. Using scissors or tin snips, cut fiberglass cloth to size one to three inches larger than area of repair. Make certain a minimum of five layers is cut for the average repair.

8. Mix desired quantity of resin and hardener in proportions of four parts resin to one part hardener. The amount mixed will vary depending on the size of repair. Generally, a mix of four tablespoons of resin and one tablespoon of hardener will be sufficient for repair of a six inch damage. Measure the resin and hardener into any suitable clean container. Do not use waxed cups for mixing and do not allow resin to enter hardener can or vice versa. Mixture which is too thin can be thickened to desired consistency by adding powdered filler. Two tablespoons of filler to one-half pint of mix will usually supply the correct consistency.

9. Saturate layers of fiberglass with mixture, then place laminates over damaged area (View C, and D, fig. 1). Smooth out wrinkles and make sure general contour of area is maintained. Wrinkles can be rolled out using a roller.

IMPORTANT: Once the resin and hardener have been mixed, the pot-life (working time) of the mix will be approximately 15 minutes. Any accidental contamination to the skin, clothing, tools, etc., must be removed during this period. Use lacquer thinner to remove resin.

10. Apply heat to applied resin material. Again place lamps 12 to 15 inches from repair area (View E, fig. 1). Allow 15 to 20 minutes for repair to cure.

11. After the repair is cured, grind, file or sand to contour (View F, fig. 1). Files other than body files may be more suitable. Feather edge and finish sand.

12. After making repair, small pits or irregularities may appear in finished surfaces. Imperfections should be repaired using a liberal amount of roving or filler mixed with resin to form a paste. See "Procedure Using Fiberglass Paste" explained later.

REPAIR PROCEDURE USING FIBERGLASS PASTE

NOTE: Fiberglass paste is used for repairing small dents, scratches and pits. Paste is made by mixing resin, hardener, and fiberglass roving or filler to the consistency of putty.

1. Perform Steps 1 and 2 explained previously under "Repair Procedure Using Fiberglass Cloth."

2. Preheat the area to be repaired using heat lamps.

3. Mix desired quantity of resin and hardener in proportions of four parts resin to one part hardener. The amount mixed will vary depending on the area of repair. Generally, a mix of two tablespoons of resin and one-half tablespoon of hardener will be sufficient for repairing a three-inch damage.

4. Add powdered fiberglass roving into the mix to thicken it into a putty state. NOTE: If repair is to be made on a vertical surface, adding of powdered filler material to mixture will reduce the tendency of hot resin to flow or run.

5. Apply the material using a putty knife or similar object. Work the material into the repair and build the material up to the desired contour. For deep filling and on vertical surfaces several layers of material may be used about 1/2 inch thick. NOTE: A hack-saw blade held flat to adjacent contour and then pulled, using sawing action across repair when the resin is in the jell stage, will remove access resin from repair.

6. Finish the repair by performing Steps 10 and 11 explained previously under "Repair Procedure Using Fiberglass Cloth."

REPLACEMENT OF RUBBER-HINGED COMPARTMENT DOORS

Removal (Fig. 2)

1. Open door to full open position; then remove screws which secure door hinge channel to hinge.

2. Lower door to a position until door is at an approximate 90 degree angle to side of coach. With the aid of an assistant, slide door from hinge.

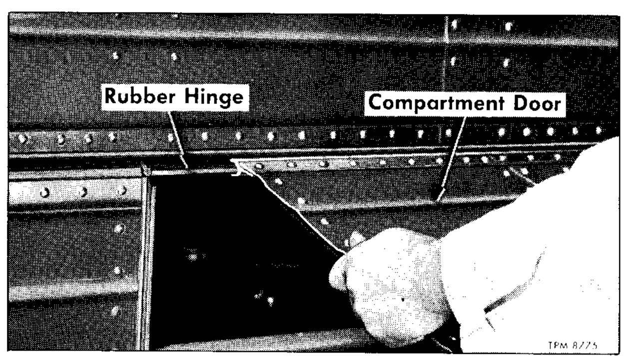


Figure 2—Replacing Rubber Hinged Compartment Doors

GENERAL BODY MAINTENANCE

Installation (Fig. 2)

1. Apply glycerin, talcum powder or a soap solution to hinge to facilitate door installation.

IMPORTANT: Do not use oil or grease on rubber hinge as hinge will be damaged.

2. With aid of an assistant at one end of door, align door hinge channel with hinge and slide door onto hinge. Secure door to hinge with screws.

SASH AND GLASS

INSERT-RETAINED GLASS

All window glass except side window sash is retained in body openings by insert-type rubber-like retainer. Retainer seal and seal insert are shown typically in figures 3 and 4.

Although possible to install retainer and seal insert without use of special tools, seal and insert installer tool (J-2189) (fig. 3) is recommended to facilitate installation.

GLASS REMOVAL

CAUTION: Wear gloves when handling glass.

NOTE: Before windshield center or lower glass section can be replaced the retention band across front of windshield must be removed. Figure 5 shows location of band and method of removing.

1. Raise one end of insert out of groove in retainer seal with pointed tool: then pull insert out by hand.

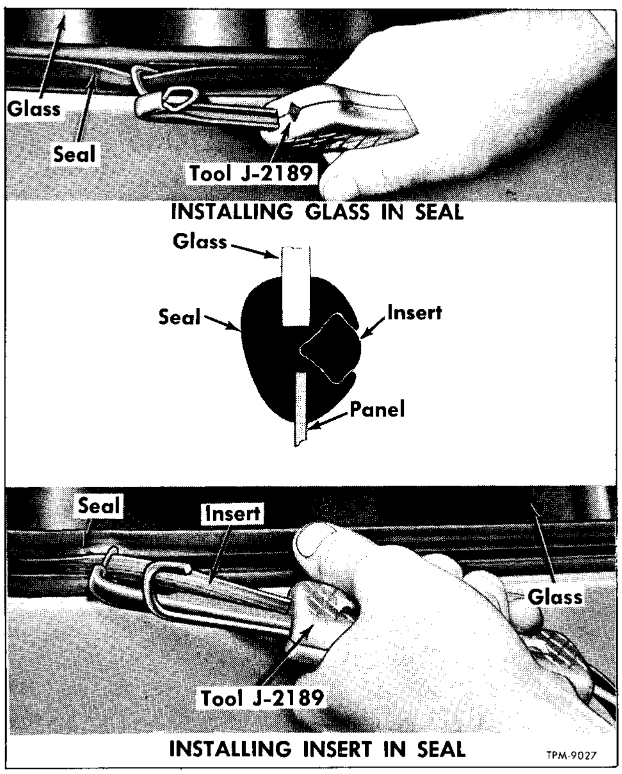


Figure 3—Insert-Retained Glass

2. Station an assistant outside of vehicle to prevent glass falling; then push glass outward from opening.

3. Remove retainer seal from glass or body opening.

GLASS INSTALLATION

1. Straighten panel flange around opening to assure a good fit in retainer seal groove.

NOTE: Windshield and rear window retainer seal is of one piece and does not require cutting.

2. Wax or apply soap solution to grooves of retainer, then position retainer seal into flange around opening, making sure seal is pushed into place in corners. Ends of retainer seal should come together at side of opening near top.

3. Cut off retainer seal ends, allowing sufficient overlap to secure a tight joint, and carefully butt into position.

4. Position new glass into groove of retainer seal. Figure 4 shows a section of windshield glass being installed. Use pin end of installer tool (J-2189) to assist locating glass in seal groove as shown in upper view of figure 3.

5. Thread end of rubber insert through handle and eye of installer tool. Refer to lower view of figure 3. At point opposite joint in retainer seal, push tool eye and end of installer into seal groove. Feed into groove in retainer seal. Use a hitching

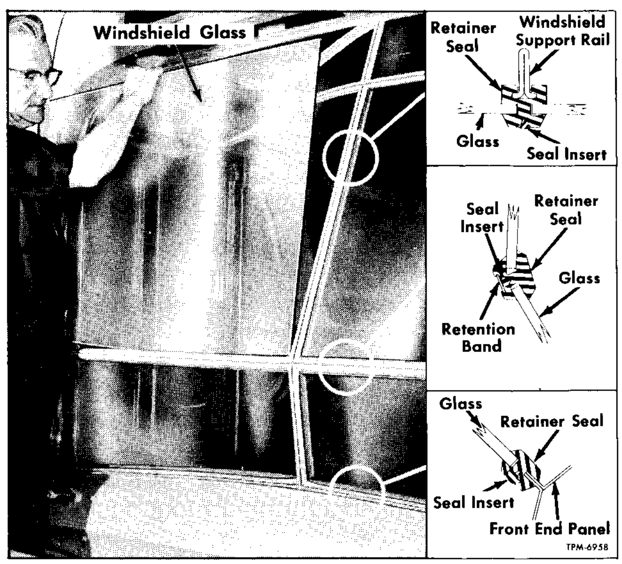


Figure 4—Installing Windshield Glass

motion to prevent elongation of insert.

6. Cut off insert, allowing overlap, and butt ends tightly into groove.

LONG SIDE WINDOWS

Long side windows consist of two sections of sliding sash and glass enclosed in a one-piece aluminum frame (fig. 6). Window can be opened by sliding front section rearward and rear section forward. Each section is retained in closed position by a latch-type lock.

EMERGENCY ESCAPE

Long side windows are hinged at top to provide passenger escape under emergency conditions.

Window is retained in closed position by bent-down tangs of two push-out clips at bottom of windows (fig. 7). Clips of U-shape construction are inserted over channel rail of window and tangs of clips are then bent down over body panel flange when window is held in closed position.

Under emergency conditions, bottoms of windows can be forced outward, causing tangs of clips to straighten out.

SIDE WINDOW REMOVAL (Fig. 6)

Side window is readily removed after first opening window to emergency escape position. With the aid of an assistant to hold window, remove screw from end of each pin, then remove pins from hinges. Push out at top of sash, then lower window assembly from opening.

SIDE WINDOW INSTALLATION (Fig. 6)

1. Before installing window, inspect window outer seal and rubber support blocks. Replace if necessary.

2. With support blocks located at bottom and ends of window frame, position window assembly

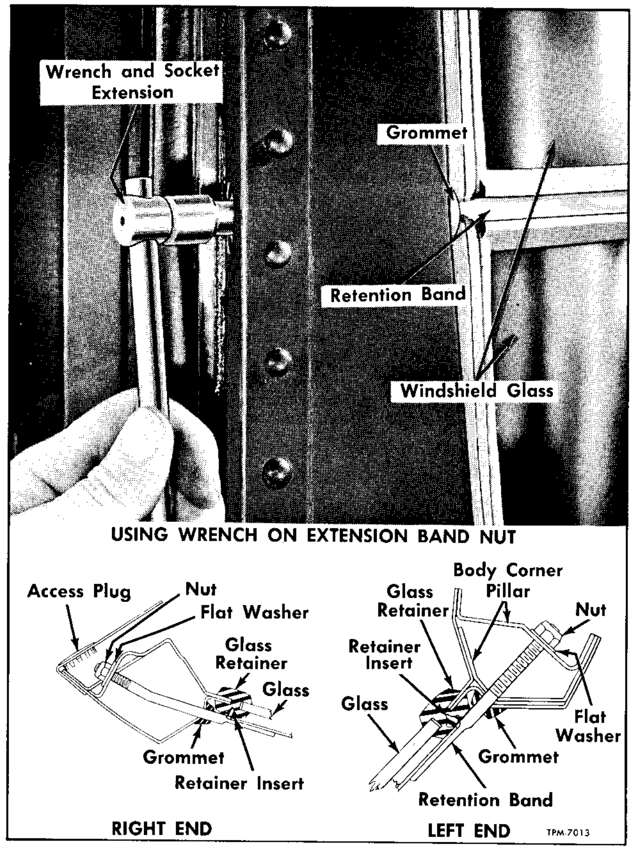


Figure 5—Windshield Retention Band Installation Views

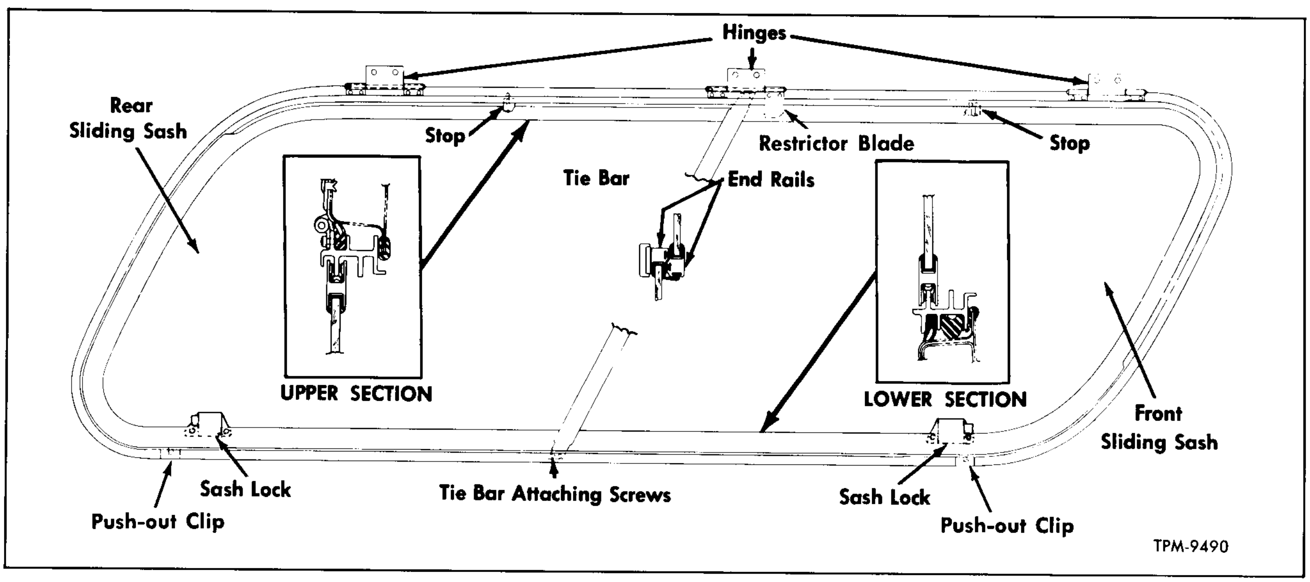


Figure 6—Long Side Window Assembly

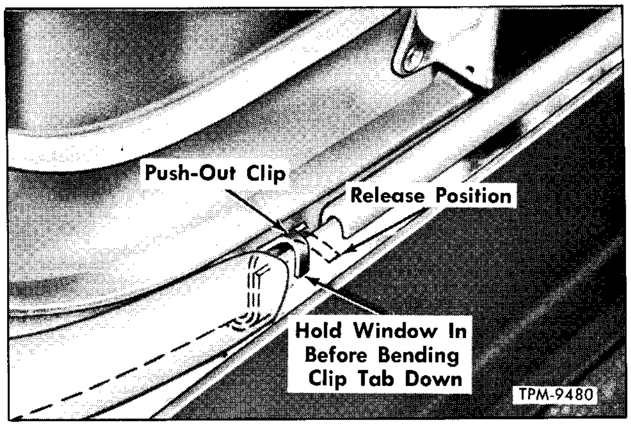


Figure 7—Emergency Escape Push-out Clip Installed

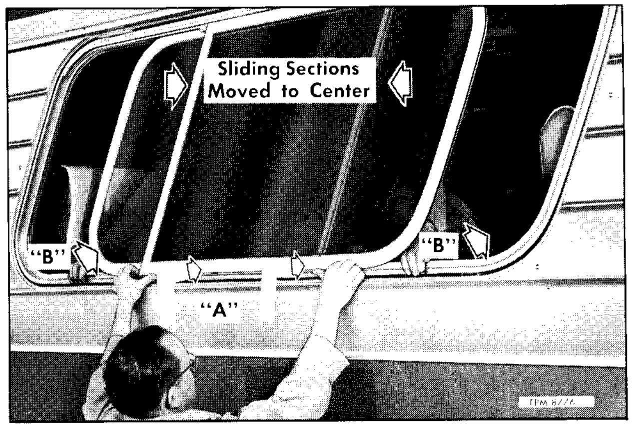


Figure 8—Installing Side Window Assembly

to opening in coach. Insert hinge pins, then secure each with a screw.

3. Locate new push-out clips to bottom of window frame, then slide front and rear sections to center (fig. 8). Raise bottom of window at point "A," then let weight of window assembly rest on window opening sill (fig. 8). Inside of coach, at points "B," pull window inward evenly to retain window in completely closed position. While holding window in closed position have assistant bend tangs of push-out clips downward as shown in figure 7.

SLIDING SASH AND GLASS REMOVAL

CAUTION: Wear gloves when handling glass.

1. Remove side window as previously directed under "Side Window Removal."

2. Remove two screws which attach one end of tie bar to window frame (View "A," fig. 9). Purpose of tie bar is to prevent window frame from spreading in the center when window is being carried or when in emergency escape position.

3. Referring to View B, fig. 9, spread window frame in the center only enough to permit removing sash and glass sections from frame channels.

4. To disassemble sash and glass sections remove screw (View A, fig. 10) at upper and lower end of section vertical-slanting end rail. Remove end rail, then carefully remove broken glass and glazing rubber from sash.

SLIDING SASH AND GLASS INSTALLATION

1. Clean glass sash channels thoroughly.

2. Position new glazing rubber on glass; then using parafin or glycerin on glazing rubber to facilitate glass installation, install glass with rubber in sash.

3. Using a strong cord as a tourniquet to press sides of frame into position as shown in View B, figure 10, install vertical-slanting end rail to sash with attaching screws.

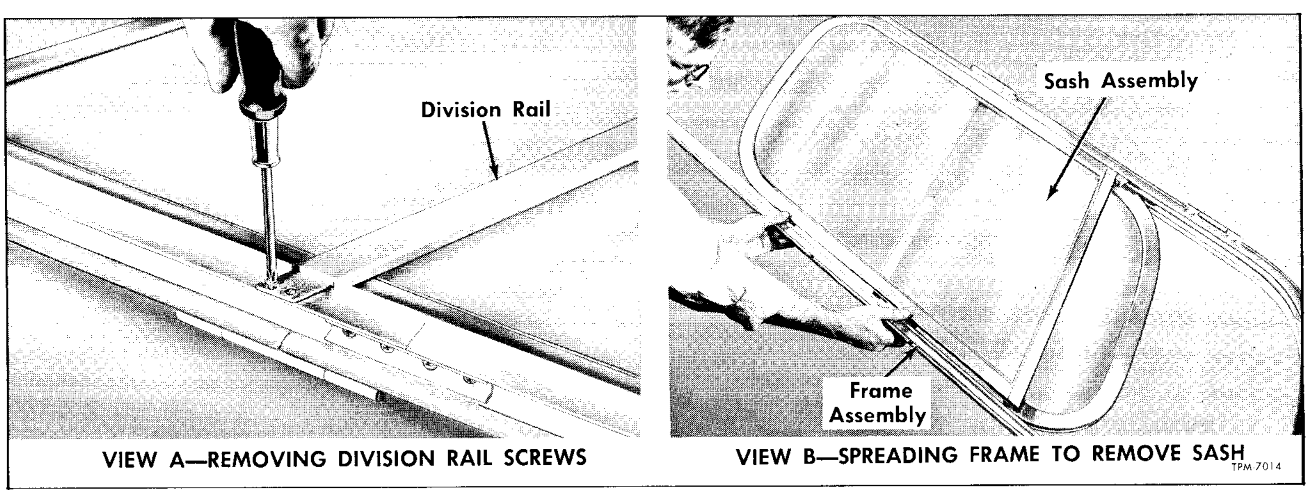


Figure 9—Replacing Long Side Window Sash Assemblies

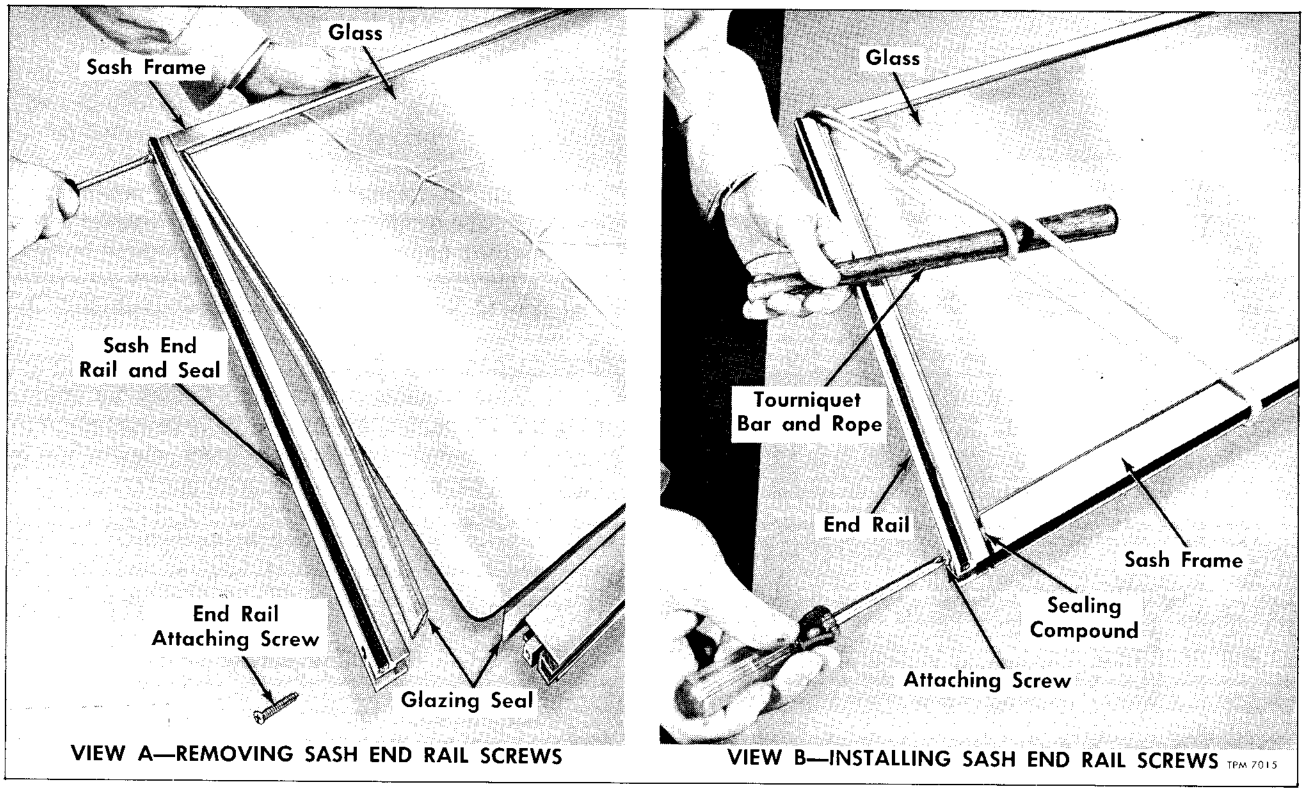


Figure 10—Replacing Sliding Section Glass

4. Spread window frame apart at center only sufficiently to allow installing sash in frame channels (View B, fig. 9).
5. Install tie bar to window frame with screws (View A, fig. 9).

SLIDING SASH POSITION LOCK

Two lock assemblies are located at bottom of window assembly for retaining sliding sections in closed or open positions.

Pushing inward on release button will free lock plunger from notch in sash rail. If release mechanism binds or fails to operate properly, remove lock assembly from sash frame.

Using a pointed or flat bladed tool, pry backing plate from rear side of lock body (fig. 11). If operation of release button does not indicate point of trouble, pull small pin which retains all moving mechanism in position. Remove components from lock body. Check for broken or distorted springs and also for rough spots on all sliding surfaces.

Install components in lock body. Sparingly apply Lubriplate to all sliding surfaces (fig. 11); then operate to check action. If operation is satisfactory, reinstall backing plate, then install lock assembly to sash. Tighten lock attaching screws firmly.

NOTE

Check operation of all sash locks at regular periodical inspections. Replace if necessary.

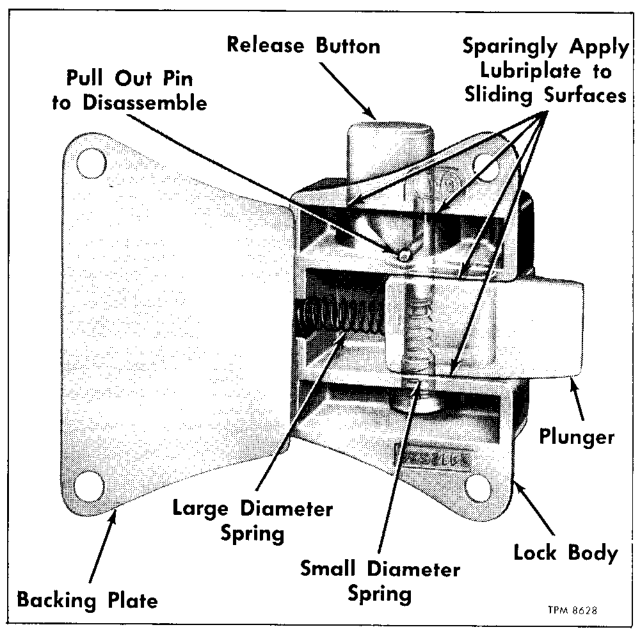


Figure 11—Side Window Lock Mechanism

GENERAL BODY MAINTENANCE

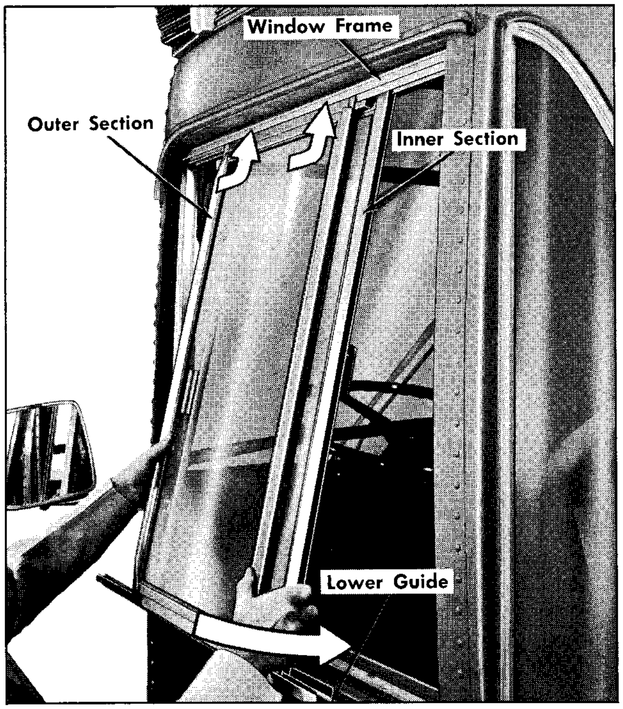


Figure 12—Replacing Driver's Window

DRIVER'S WINDOW REPLACEMENT

REMOVAL (Refer to Fig. 12)

1. At bottom of window, remove four screws which attach window lower guide to window outer frame ledge.

NOTE: Center or forward sliding section can be moved fore or aft for access to attaching screws.

2. While assistant within coach forces bottom of sash sections outward, grasp window as shown in figure 12 and lower from window opening.

INSTALLATION

1. Slide window sections to center as shown in figure 12, then lift sections to openings and engage section upper channels over mating guide rails of window outer frame in body opening.

2. Swing bottom of sections inward and at same time raise to support bottom guide on window outer frame ledge. Install four screws attaching bottom guide to ledge. Tighten screws firmly.

IMPORTANT

Heads of screws must not contact bottom of sliding sections when being moved fore or aft.

MISCELLANEOUS EQUIPMENT

WINDSHIELD WIPERS

Two air-operated windshield wipers are mounted in front panels, below windshield. Air pressure for wiper operation is supplied by auxiliary air system, fed in turn from coach main air system. A pressure regulating valve, interposed in air lines (fig. 13), prevents depletion of main air system when pressure in main air system falls below approximately 65 psi.

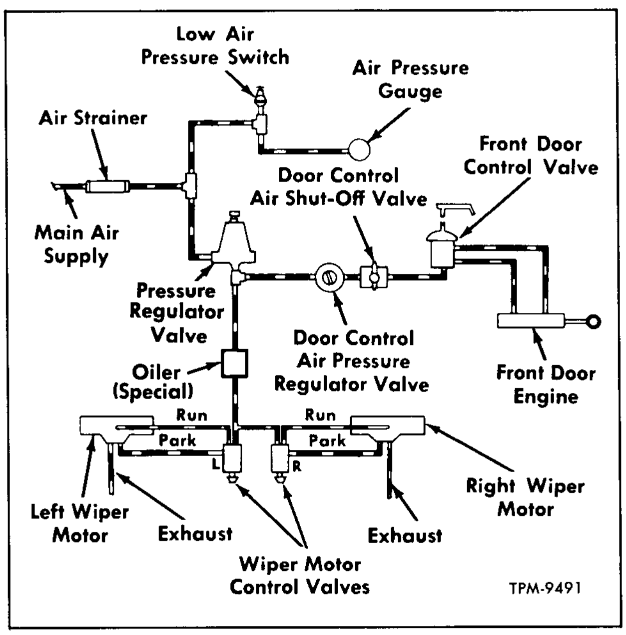


Figure 13—Schematic Air Line Diagram

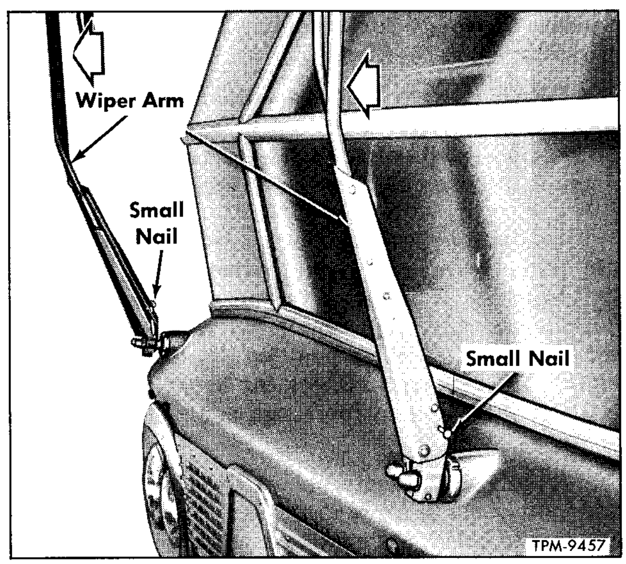


Figure 14—Wiper Arms Retained From Windshield

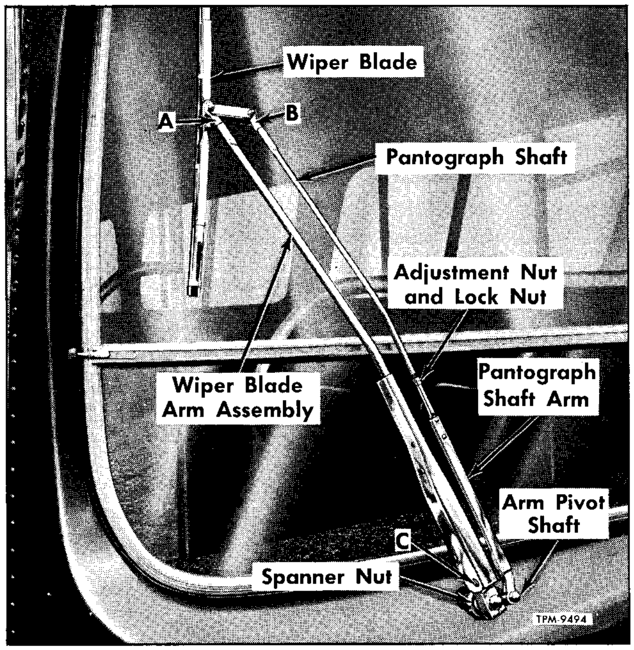


Figure 15—Windshield Wiper Arm and Blade Installed

Windshield wiper motors are individually controlled by valves, mounted on dash panel at left of steering column. Valves can be partially disassembled for cleaning as explained later.

Refer to BRAKES (SEC. 4) for maintenance and repair information on auxiliary system air pressure regulator valve, air lines, and connections. Figure 13 illustrates typical systematic diagram of windshield wipers and controls.

Operation of wipers can be checked without wetting windshield glass by inserting a small nail into holes at base of each wiper arm after pulling arms forward (fig. 14). This will retain blades from contacting glass.

NOTE: Some coaches are equipped with a special oiler device which is located in the wiper air supply line under dash. Air supply to wiper motors must first pass through oiler where some lubricant is picked up and is then carried into the wiper motors for automatic lubrication of internal parts.

Servicing of oiler device is covered in LUBRICATION (SEC. 13) of this manual. Service instructions are also located on side of oiler unit.

IMPORTANT: Before disconnecting any wiper lines or replacing any wiper unit, deplete air pressure from auxiliary air system.

Service repair kits are available for arm tip and bushing assemblies ("A" and "B," fig. 15) and the arm bushing and rivet assembly ("C," fig. 15). Repair instructions are included in kit "C."

WIPER BLADE ANGLE ADJUSTMENT (Fig. 15)

Pantograph shaft length is adjustable to allow setting wiper blade angle. Each blade should travel across windshield in a position so that when the arm is at the end of its outward sweep, the wiper blade should be parallel with edge of windshield as shown in figure 15. If necessary, adjust angle of blade as follows:

1. Loosen lock nuts on pantograph shaft (fig. 15).
2. Remove crown nut which attaches shaft arm to pivot shaft. Remove shaft arm from shaft, then while holding outer end of pantograph shaft, turn shaft arm to shorten or lengthen overall length of shaft assembly.
3. Reinstall arm on pivot shaft. Force arm and blade across wetted glass or retain arms outward with nail (fig. 14) and check angle of blade.
4. Repeat adjustment if necessary, then install crown nut on pivot shaft. Secure nut firmly. Tighten lock nuts on pantograph shaft.

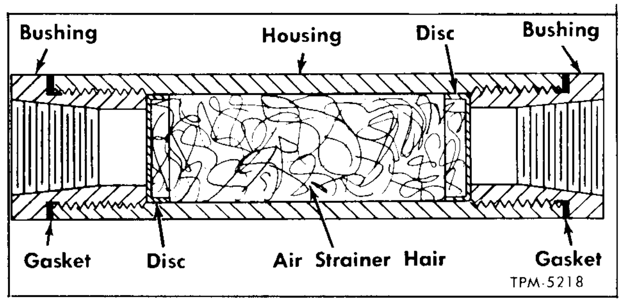


Figure 16—Windshield Wiper Air Strainer

WIPER MOTOR AIR STRAINER

Windshield wiper air strainer (fig. 16), mounted in air line behind panel at left of dash should be removed, disassembled, and cleaned annually. Strainer is shown installed in figure 3 under "Doors and Controls." Soak strainer filter hair in cleaning solvent to clean. Dry filter hair, then reassemble strainer. Tighten strainer end bushings firmly after cleaning.

After installing strainer, check for air leaks at line connections.

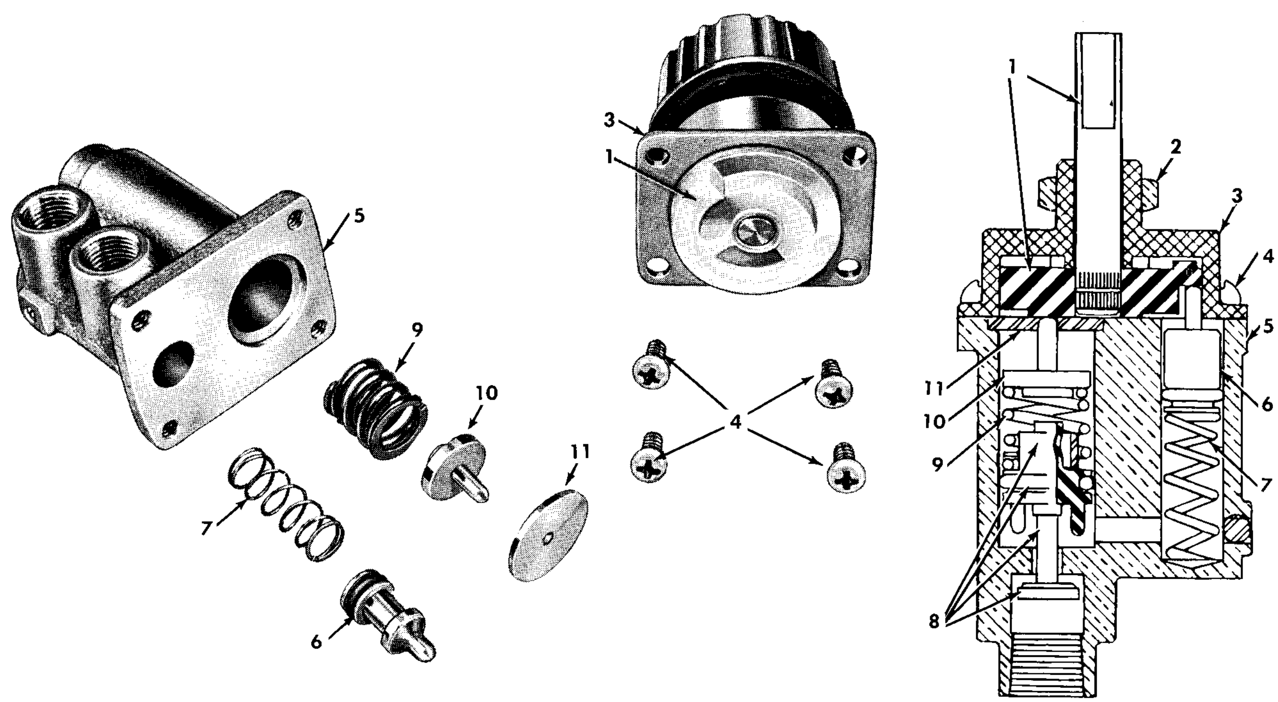
WIPER MOTOR HAND CONTROL VALVE

Individual wiper motor hand control valves (fig. 17) can be removed from vehicle for cleaning or repair if necessary. Before removing valve assembly, exhaust pressure from air supply tank.

REPAIR

NOTE: Key numbers in text refer to figure 17.

1. Remove four screws (4) which attach cover (3) to body (5). Separate cover from body as shown.
2. Pull parking valve stem (6) with rubber O-ring from valve body. Remove valve spring (7).



EXPLODED VIEW OF VALVE

SECTIONAL VIEW OF VALVE

1 Cam Rod Assy.
2 Lock Nut
3 Cover
4 Cover Attaching Screws
5 Body
6 Parking Valve Stem Assy. (Incl. O-ring)
7 Spring (19/64" O.D.)
8 Valve, Seat, and Retainer Assy.
9 Spring (31/64" O.D.)
10 Pressure Regulating Ram
11 Guide Washer

TPM-8713

Figure 17—Windshield Wiper Hand Control Valve

3. Using needle-nose pliers, pull pressure regulating ram (10) with guide washer (11) from valve body. Remove spring (9).

NOTE: Do not disassemble valve further.

4. Clean all parts in solvent, then applying air pressure into valve body ports, blow any dirt and solvent from valve body. Using a wood stick or other soft material, force valve, seat, and retainer assembly (8) back and forth within body, then repeat cleaning procedure. NOTE: If retainer assembly appears damaged, the entire hand control valve assembly should be replaced.

5. Apply small quantity of wiper motor grease to valve surfaces and rubber O-rings.

6. Referring to sectional view, assemble valve as shown, then install and check operation.

WIPER MOTOR REPLACEMENT AND OVERHAUL

REPLACEMENT

Removal

1. Remove wiper arm linkage at front of windshield. Remove nuts and seal washers from motor linkage shafts.

2. Exhaust pressure from air supply system.

3. Disconnect air lines at wiper motor.

4. Remove two bolts which attach motor bracket to body panel. Remove motor unit.

Installation

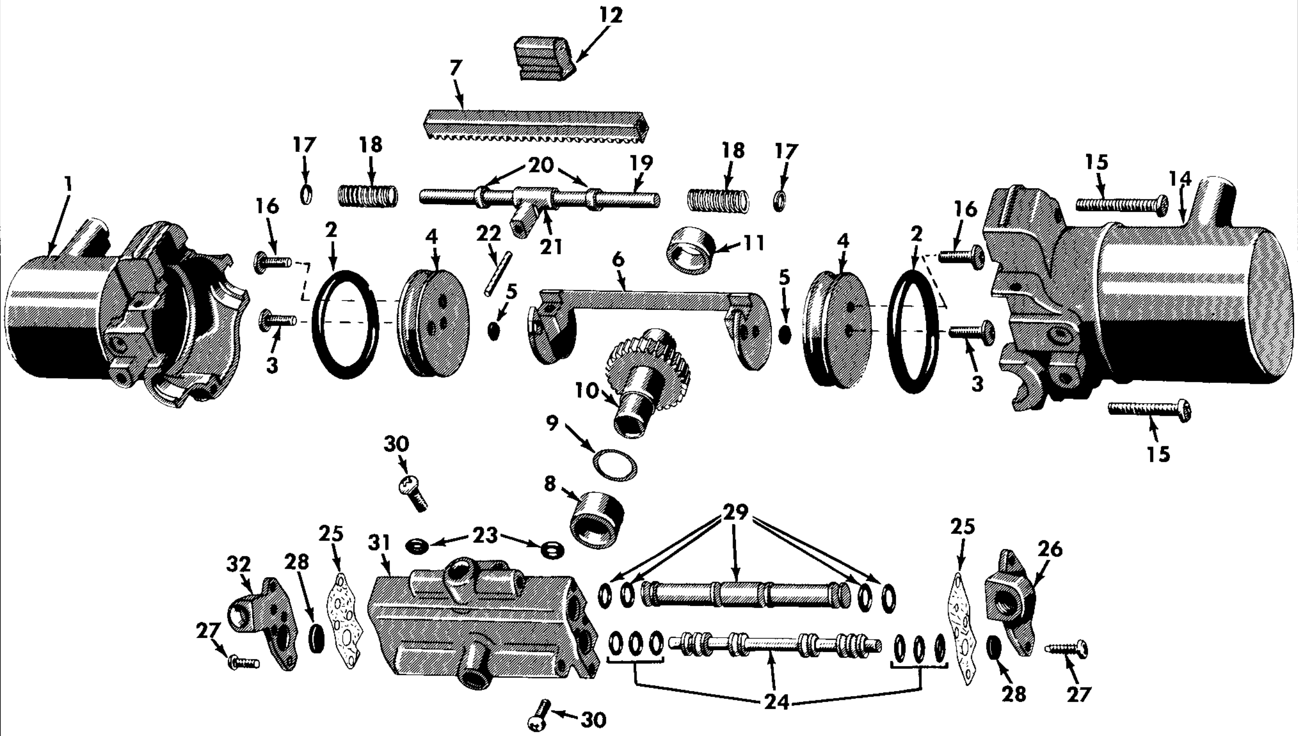
1. Place wiper motor with assembled linkage into position and attach to body panel with four screws and washers. Also at front of vehicle install spanner nut which retains motor shaft in position. Tighten nut to 18 to 20 foot-pounds torque.

2. Connect air lines to motor valve ports.

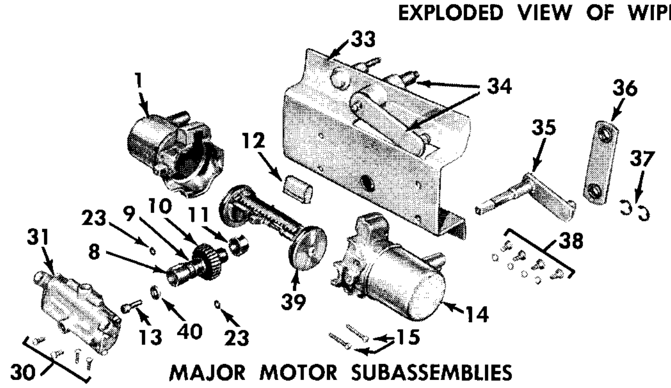
3. Build up air supply (65 psi or more).

4. Operate motor. While observing the cycling of wiper arm shaft, turn wiper off when shaft is located in park position (blades park at center of windshield). Apply small quantity of Lubriplate to motor and pivot shafts, then engage wiper arm over serrations of shaft; at same time install pantograph shaft to pivot shaft. Tighten arm clamp screw and install crown nut to pivot shaft.

IMPORTANT: Make sure pantograph shaft arm is free to rotate on pivot shaft as too many shim washers (if used) under crown nut will cause binding of linkage.



EXPLODED VIEW OF WIPER MOTOR ASSEMBLY



MAJOR MOTOR SUBASSEMBLIES

1 R.H. Piston Body Assy.
* 2 Rubber O-Ring
3 Screw Assy.
* 4 O-Ring Adapter (R.& L.)
* 5 Rubber Disc
6 Piston Rack
7 Gear Rack
8 Bearing (Rear)
9 Shim Washer
10 Gear and Sleeve Assy.
11 Bearing (Front)
*12 Thrust Block
13 Shaft Retaining Screw
14 L.H. Piston Body Assy.
15 Body Attaching Screws
*16 Piston Rack Attaching Screws
17 Steel Washer
18 Spring
19 Turnbuckle Rod
20 Reverser Stop Floating Piston Tubing
21 Reverser Tee
*22 Valve Pin
*23 Valve Body O-Ring
*24 Secondary Rod Assy.
25 Gasket
26 Parking End Plate (R.H.)
27 End Plate Attaching Screw
*28 Disc
*29 Primary Rod Assy.
30 Valve Body Attaching Screws
31 Valve Body
32 Parking End Plate (L.H.)
33 Motor Mounting Bracket Assy.
34 Wiper Arm Shaft Assy.
35 Motor Shaft and Link Assy.
36 Link
37 Link Retainers
38 Motor Attaching Bolts
39 Piston Assy.
40 Washer

(*) Part of Repair Kit.

TPM-9492

Figure 18—Windshield Wiper Motor Assembly

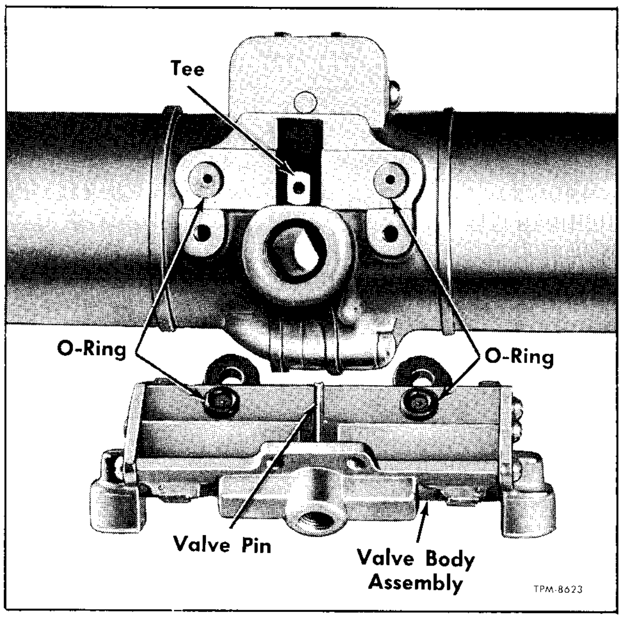


Figure 19—Windshield Wiper Motor Valve Body Removed

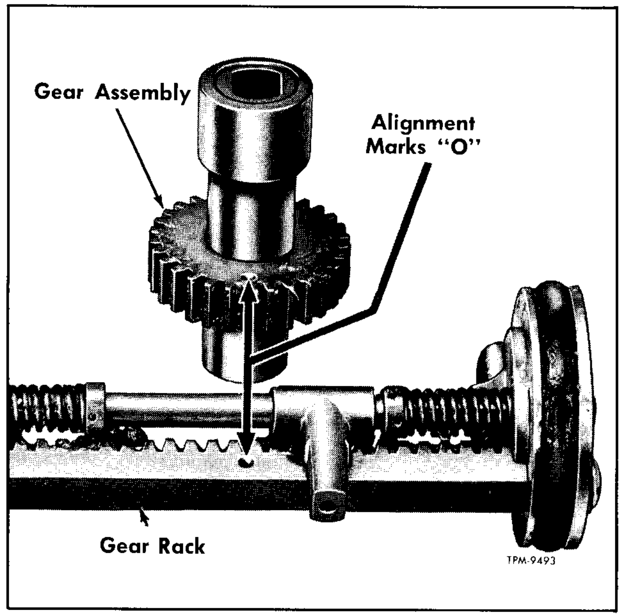


Figure 20—Gear-To-Gear Rack Timing Marks

OVERHAUL

NOTE: A kit is available including all necessary parts to properly service motor. Kit includes all items indicated by an asterisk (*) in figure 18 plus 1 oz. of recommended lubricant.

NOTE: All key numbers in following text refer to figure 18.

Separation of Major Sub-Assemblies

NOTE: Lower left view of figure 18 shows major subassemblies.

1. Remove retainer (37) which attaches link (36) to motor shaft assembly (35).
2. Remove screw (13) and washer (40) which attach motor transmission shaft (35) into wiper motor. Pull shaft assembly from motor assembly.
3. Remove four bolts (38) which attach mounting bracket assembly (33) to motor. Remove bracket.
4. Remove four screws (30) which attach wiper control valve body (31) to motor piston body assemblies. Remove valve body and body O-rings (23). Figure 19 shows body separated.
5. Place right half of piston body (1) (half with threaded screw holes) in vise so that attaching screws are up. CAUTION: Tighten vise ONLY enough to hold body.
6. Remove screws (15) which attach piston bodies together.
7. Slowly lift off upper piston body (14).
8. Note position of alignment marks ("O") on gear (10) and gear rack (7) (fig. 20). Remove gear assembly, noting locations of thick and thin bearings and the chamfer on the rear bearing.
9. Remove thrust block (12).
10. Note position of valve reverser tee (21) in body slot, and remove the piston assembly (39).

Build-up of Major Sub-Assemblies

1. Apply clean wiper motor grease to all moving or sliding parts.
2. With right piston body assembly (1) placed in vise, install piston assembly (39) into piston body.
3. Install thrust block (12). Make sure pin notch is properly positioned to align with body attaching screw later.
4. Assemble bearings (8) and (11) with shim washer (9) on gear and sleeve assembly (10).

NOTE: Make sure chamfer on rear bearing is toward the rear. Install gear and bearings into body. Make sure alignment marks ("O") on gear and rack are aligned (fig. 20).

5. Install left piston body assembly (14) over piston assembly. Attach bodies together with screws (15). Tighten screws firmly.
6. Referring to figure 19, place O-rings (23) on bosses of valve body (31) as shown. Carefully place valve body to motor piston bodies, then install valve body attaching screws (30). Tighten screws firmly.
7. Attach mounting bracket (33) to motor with four bolts (38) and lock washers.
8. Install motor transmission shaft assembly (35) to motor, making sure shaft link is positioned to align with upper wiper arm shaft lever. Install washer (40) and shaft retaining screw (13).
9. Install link (36) to shaft and secure with retainer (37).

Wiper Motor Valve Disassembly and Assembly

1. Remove screws (27), then remove parking end plate (26 and 32) and gaskets (25) from valve body (31). Remove disc (28) from end plates.
2. Unscrew valve pin (22) projecting from valve body side.
3. Push out primary (alum.) rod (29) and secondary (nylon) rod (24) from valve body.
4. Remove rubber O-rings from rods.
5. Clean the valve body, end plates, mounting screws and rods with solvent and wipe rubber O-rings with clean cloth. Examine all parts for wear and defects. Replace all worn and defective parts.
6. Apply wiper motor grease to valve rods and rubber O-rings.
7. Install rubber O-rings on rods, then push rods into valve body. NOTE: Make sure tapped hole in primary rod (29) is in position to align with valve pin (22).
8. Thread valve pin (22) into primary rod.
9. Make sure rubber disc (28) are installed in end plates (26 and 32). Install end plates to valve body with screws (27).

Wiper Motor Piston Disassembly and Assembly

1. Remove rubber O-rings (2) from O-ring adapters (4).
2. Remove screws (3 and 16) at each end of piston assembly, then lift off O-ring adapters (4). Remove gear rack (7).
3. Note assembled position of reverser tee (21), springs (18), and steel washers (17), then disassemble components. Reverser stop floating piston tubings (20) are retained to turnbuckle rod (19) with small pin.
4. Clean all parts thoroughly, then examine for wear and abrasion. Replace parts if required. Grease rubber O-rings and gear rack liberally.
5. Referring to figure 18 assemble tee (21), tubing (20), springs (18), and washers (17) on turnbuckle rod (19) as shown. Position gear rack (7) to piston rack (6), then with rubber discs (5) located in recesses at inner side of O-ring adapters (4), locate right and left O-ring adapters to piston rack and secure with screws (3) and (16). Tighten screws firmly.

PASSENGER SIGNAL BUZZER AND CHIME

Either a buzzer unit or a chime unit may be used as passenger signal to driver. Figure 21 shows a buzzer unit and figure 22 shows a chime unit. Either unit is mounted to roof crown panel above driver.

Signal is sounded by switches, mounted on trim paneling at rear of front door and on driver's window rear post, and operated by pull cords at top of coach side windows.

Signal circuit, protected by number 7 circuit breaker is fed through "BUZZER" switch when "MASTER" switch is in "DAY" or "NITE" position.

"BUZZER" control switch is located on recessed switch panel at left of driver.

Refer to "Alarm and Signal Circuits Diagram," at end of this manual for additional information.

NOTE: Information pertinent to either signal unit is covered under applicable headings below.

BUZZER UNIT (Refer to Fig. 21)

Points Maintenance

Contact points of buzzer should be inspected

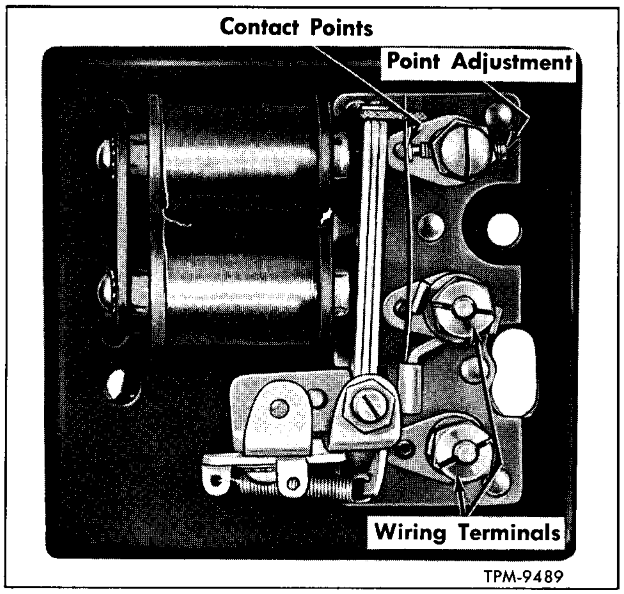


Figure 21—Passenger Signal Buzzer

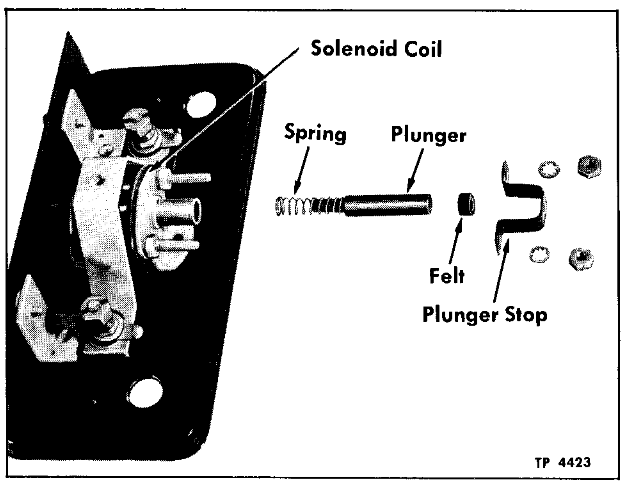


Figure 22—Passenger Signal Chime

GENERAL BODY MAINTENANCE

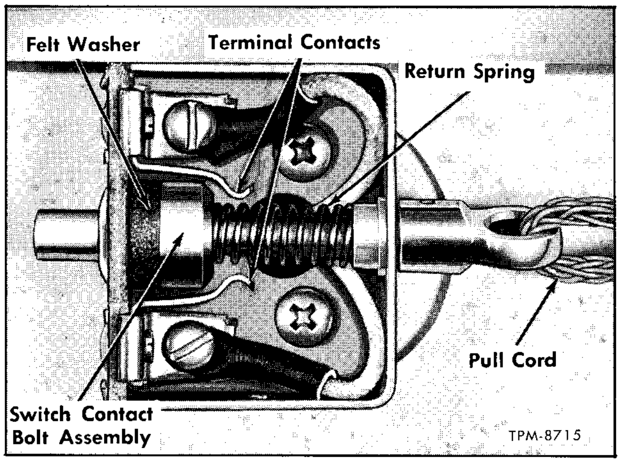


Figure 23—Passenger Signal Cord Switch Cover Removed

periodically and cleaned if necessary. At regular intervals cover should be removed from buzzer and contact points inspected for corrosion or other defects.

Test

If buzzer fails to operate with either switch, remove cover from buzzer and inspect contact points. Points should be clean and in contact. Make sure terminal nuts are tight.

If buzzer still fails to operate, check circuit continuity in following sequence, using a voltmeter or a test light having a 12 volt 1.5 c.p. bulb.

1. Turn on "BUZZER" switch on recessed switch panel and place "MASTER" control switch in "DAY" or "NITE" position. With one test lead grounded, touch other lead to one and then the other buzzer terminals. If no current is indicated at either terminal, defective wiring or control switch between control panel and buzzer is indicated.
2. If current is obtained at only one terminal, points are not making contact, or coil is open circuited. Repair or replace unit.
3. If current is obtained at both buzzer terminals and buzzer does not sound, repair or replace unit.
4. To check circuit (except buzzer), remove leads from buzzer and attach each lead to voltmeter or test light lead. If current indication is obtained when each signal cord is pulled, circuit is operating properly.
5. If current indication is not obtained, switches and wiring should be carefully checked for open circuits.

CHIME UNIT (Refer to Fig. 22)

Maintenance

Solenoid-type chime has no contacts and requires no regular maintenance.

If chime fails to operate, remove chime cover. With "BUZZER" switch in "BUZZER" position and with "MASTER" switch in "DAY" or "NITE" position, check for current indication at both terminals of chime. Current should be obtained at one terminal. Ground other (dead) terminal with jumper wire.

If chime now sounds, check circuit continuity from chime, through switches, to ground. If chime does not sound, make sure plunger operates freely. Disassemble chime as shown in figure 22. Failure may be due to burned out coil, or may be caused by felt positioned in such a manner as to prevent operation of plunger.

PULL-CORD SWITCH

If inspection indicates chime or buzzer is in operating condition, check continuity of current through the passenger signal pull-cord switch. If necessary, remove cover from pull-cord switch as shown in figure 23. Clean terminal and bolt contacts. Inspect switch contacts for loose connections. Operate pull cord and observe mechanism for possible disorder. A short piece of jumper wire placed to each terminal screw will check circuit continuity.

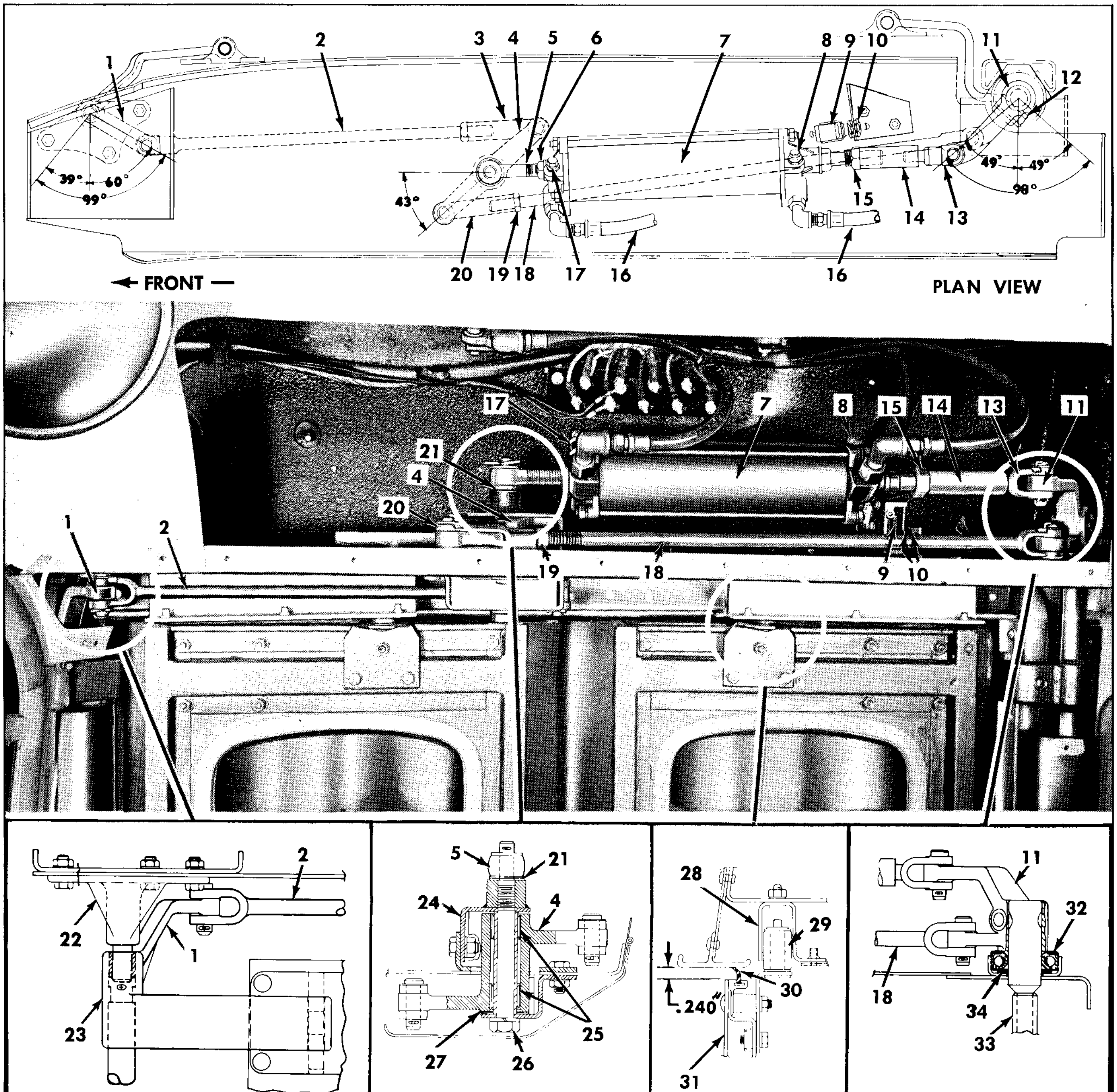
SPECIFICATIONS

Windshield Wiper Motor
- Make .... Sprague Devices Inc.
- Model .... M516-140°

Passenger Signal Chime
- GM Part Number 2164961
- Type .... Single Tone

Passenger Signal Buzzer
- GM Part Number 287886
- Stamped (on cover) 22983

Doors and Controls



1 Front Lever	13 Eye	24 Idler Lever Support
2 Front Connecting Rod	14 Rod Turnbuckle	25 Bushings
3 Rod Yoke	15 Lock Nut	26 Pivot Bolt
4 Idler Lever	16 Air Lines	27 Washers
5 Eye	17 Speed Metering Screw	28 Guide Channel
6 Eye Lock Nut	18 Rear Connecting Rod	29 Guide Roller
7 Door Engine Assembly	19 Lock Nut	30 Door Upper Seal
8 Speed Metering Screw	20 Yoke	31 Door Assembly
9 Switch Assembly	21 Shims	32 Bearing Assembly
10 Switch Lock Nuts	22 Shaft Upper Pivot Bracket	33 Door Shaft Assembly
11 Rear Lever	23 Door Shaft Assembly	34 Shims
12 Clamp Bolt		

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Figure 1—Front Door Engine and Linkage

DOORS AND CONTROLS

STANDARD EQUIPMENT

Front doors are of the full-air operated type, whereas the rear doors are of push type. Other types of door controls used as special equipment are described later in this section. Both front and rear doors however, are controlled by door valve mounted on panel at left of driver.

When rear doors are unlocked, electrical circuit is completed to operate brake and accelerator interlocks.

Figure 1 illustrates arrangement of front door operating mechanism. Rear push type door arrangement is shown in figure 2.

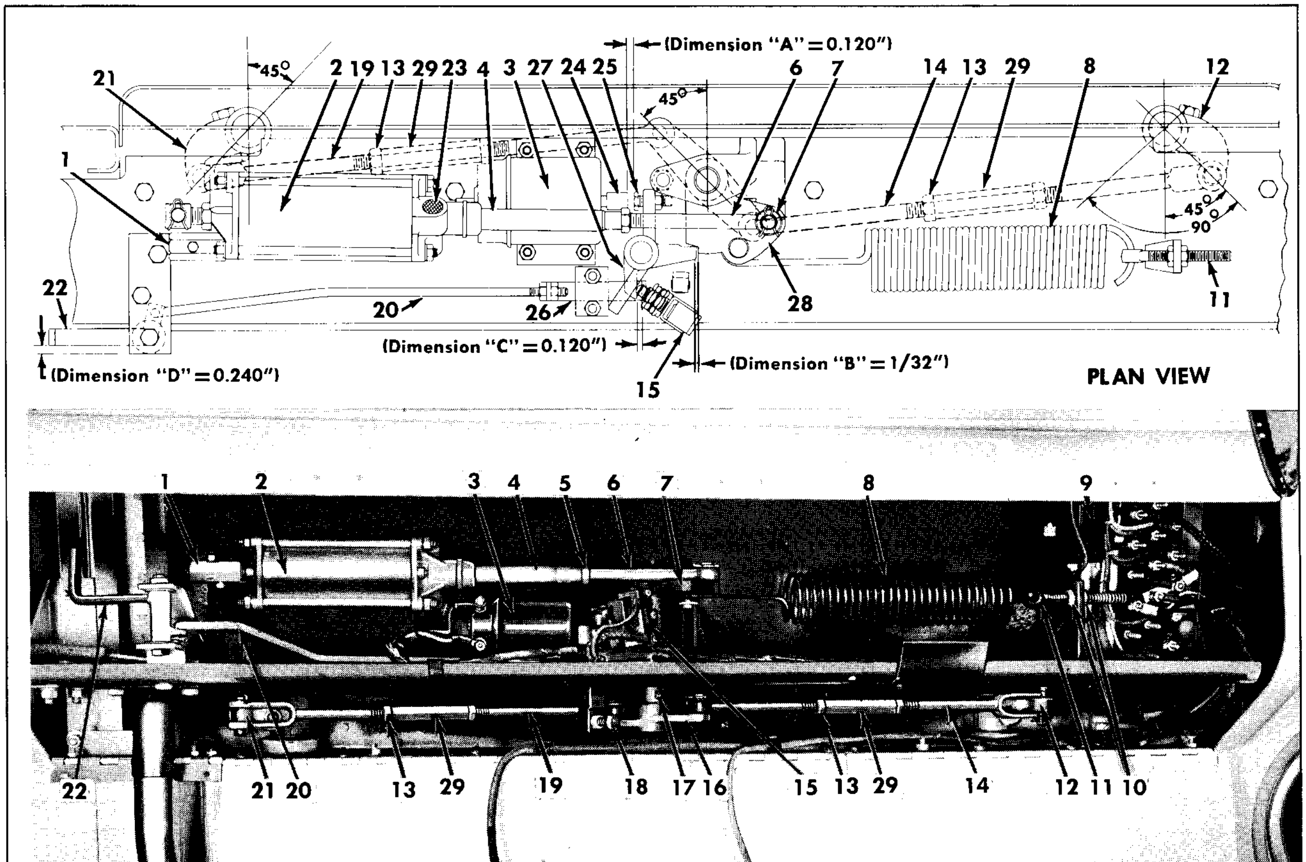
Maintenance on door controls is explained later under respective headings.

Figure 24 shows a schematic arrangement of standard door control units, lines, and wiring. Refer to figures 25 and 26 for special equipment door controls.

DESCRIPTION AND OPERATION

FRONT DOORS

Front doors are controlled by a valve which admits air pressure to one side of piston in door



1 Closing Speed Control Valve Assembly
2 Check Cylinder Assembly
3 Unlock Solenoid Assembly
4 Cylinder Piston Rod
5 Lock Nut
6 Piston Rod Eye
7 Check Cylinder Lever
8 Return Spring
9 Door Switch Relay Assembly
10 Lock Nuts
11 Return Spring Eye
12 Door Rear Lever
13 Lock Nut
14 Rear Connecting Rod
15 Rear Door Switch Assembly
16 Connecting Rod Idler Lever
17 Lubrication Fitting
18 Stop Screw
19 Front Connecting Rod
20 Emergency Manual Unlock Rod
21 Door Front Lever
22 Emergency Manual Unlock Lever
23 Check Cylinder Breather
24 Solenoid Plunger Cap
25 Adjustment Screw
26 Slide Bar
27 Cam Lever
28 Lock Cam
29 Turnbuckle

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Figure 2—Door Check Cylinder and Linkage—Push Type

engine and at same time opens port for exhausting air from opposite side of engine piston. When control valve handle is placed in position for closing door, air is admitted to opposite side of piston to reverse the action.

REAR DOORS

Rear doors are opened manually by passenger leaving coach. Doors are retained in locked-closed position by a spring-loaded lock lever which engages notch on door lock cam. Lock lever is retracted from notch in lock cam to unlock the door by plunger of door electrical solenoid when solenoid is energized. Solenoid action occurs when driver places door control valve in rear door-open position when the coach engine is running. After passenger alights from coach, doors are immediately returned to closed position by a large return spring mounted to door linkage above door. Slamming of door upon closing is prevented by a check cylinder assembly equipped with an adjustable speed control valve. Check cylinder is attached to door linkage and speed control valve is installed at pivot end of check cylinder as shown in figure 2. As doors are pushed open, piston in cylinder is pressed inward, forcing air out the speed control valve. Valve is designed with a spring-loaded check ball which allows rapid flow of exhausting air from cylinder. As the door starts to close, valve check ball seats, closing passage, and the only air which enters cylinder is drawn into cylinder by piston through small orifice at upper end of control valve. Thus door closing action is retarded.

Door linkage adjustment is explained later under "Rear Door and Linkage Adjustment." Refer to "Door Control Wiring Diagram" (fig. 24) for rear door circuits.

FRONT DOOR AIR SHUT-OFF VALVE

Air shut-off valve (fig. 3), mounted on panel at left of driver, is connected in system as shown on "Wiring and Air Line Diagram" (fig. 24).

Valve controls the supply of air to operate front door engine. When valve is turned to "OFF" position, door can be manually opened and closed. Valve is installed as shown in figure 4.

MAINTENANCE

Air shut-off valve requires no maintenance. However, if valve is disassembled due to leakage or other reasons, valve face should be cleaned, then coated sparingly with chassis grease.

REPAIR

Entry of foreign matter may cause scoring of valve face with resultant leakage. In the event of leakage, valve should be ground.

Exhaust air from system; then remove air

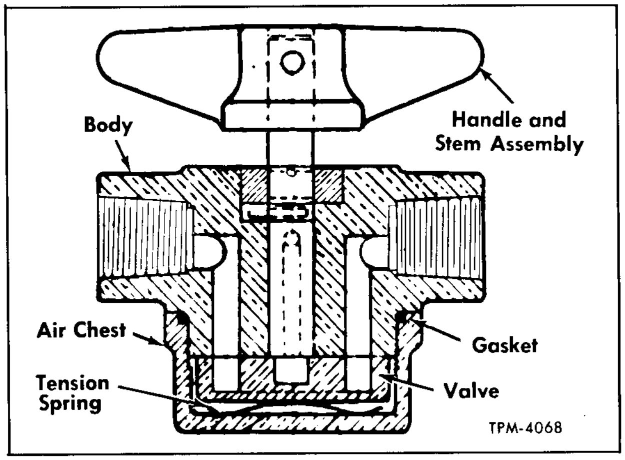


Figure 3—Front Door Air Shut-off Valve

shut-off valve. Remove air chest by unscrewing. Apply a small quantity of fine grinding compound mixed with gasoline to face of valve. Grind valve against valve face until all scores have been removed. Clean parts thoroughly in gasoline and blow out air passages with compressed air to remove all particles of compound. Apply a light film of chassis grease before assembling.

DOOR CONTROL VALVE

Door control valve (fig. 5) is mounted below window sill at left of driver (fig. 4). Valve should be lubricated semi-annually. Turn door shut-off valve handle at left of driver to "OFF" position. Remove valve from coach then disassemble.

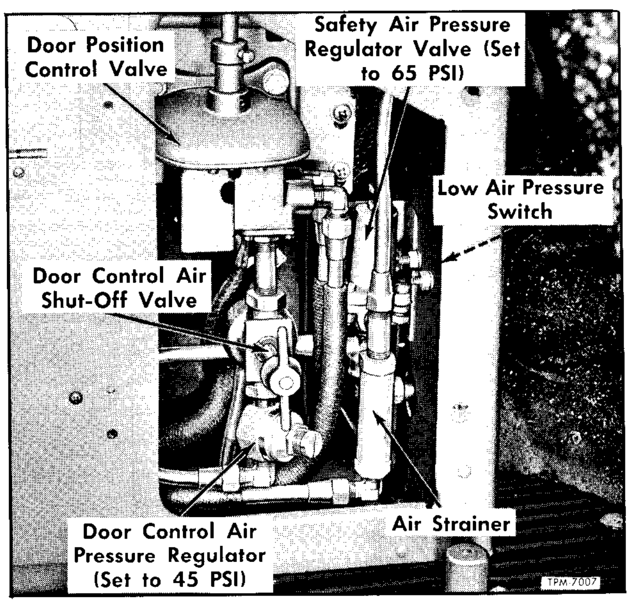


Figure 4—Door Control Units At Left of Driver

DOORS AND CONTROLS

DISASSEMBLY

NOTE: Key numbers in text refer to figure 5.

1. Remove three screws which attach air valve body (8) to valve cover assembly (1). Separate valve body from cover.
2. Remove six screws which attach valve manifold (10) to valve body. Carefully tap manifold free then remove valve springs (11), and valves (7).
3. Push valve plungers (3) from valve body. Remove O-ring seals (6) from plungers.
4. Remove three screws which attach switch body (15) to cover. Remove body then pull switch plunger (14) and spring (13) from switch body.
5. Remove set screw (18), plunger spring (17), and index plunger (16) from valve cover (1).
6. If necessary, remove two screws attaching electric switch (12) to switch body (15). Remove switch.
7. From underside of cover remove cam plate and shim washer (4).

CLEANING AND INSPECTION

NOTE: Key numbers in text refer to figure 5.

Clean all parts except electric switch in cleaning solvent. Inspect manifold gasket (9), valve springs (11) and (13), valves (7), and valve plunger O-ring seals (6). If worn, or deteriorated, replace.

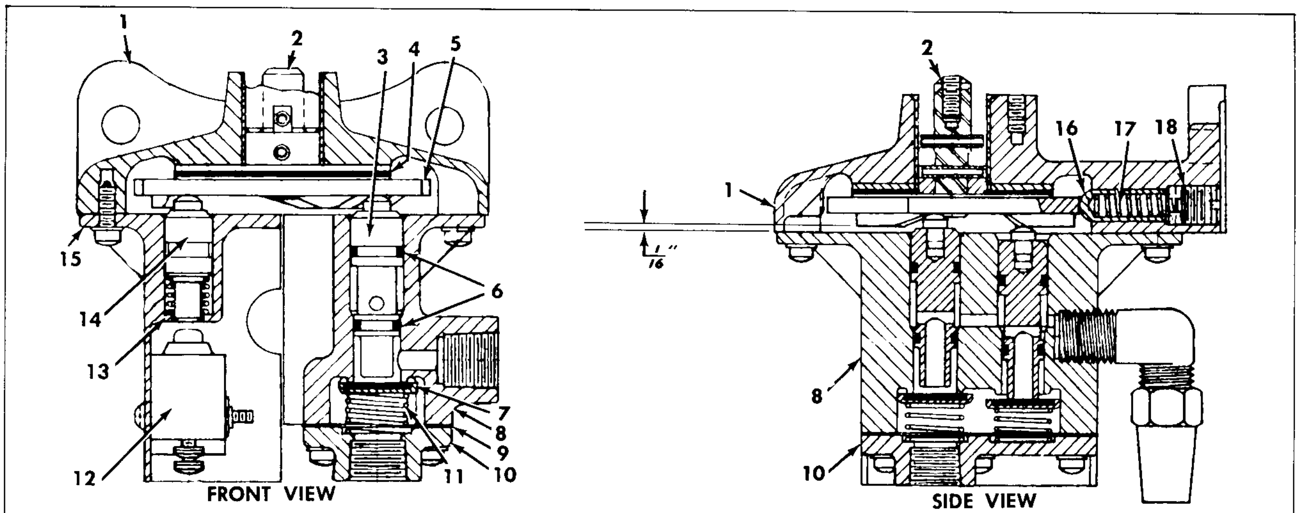
ASSEMBLY

NOTE: Key numbers in text refer to figure 5.

1. Apply light film of barium-type grease to O-ring seals (6). Install seals in plunger grooves.
2. Install plungers (3) with seals into bores of valve body (8). Install valves (7), springs (11), gasket (9), and manifold (10) to valve body. Make sure valve springs are seated in recesses of manifold before tightening six manifold attaching screws and lock washers. Tighten screws evenly and firmly.
3. Apply light film of chassis grease to plunger (14), then insert switch plunger spring (13) and plunger into switch body (15).
4. If cam plate (5) was removed from valve cover (1), install shim washers (4) and cam into valve cover. Maintain 1/16" dimension as shown.
5. Insert index plunger (16), plunger spring (17), and set screw (18) into valve cover (1). NOTE: Plunger must engage detent in cam plate. Turn cam plate if necessary.
6. Install switch and valve bodies (15) and (8) to valve cover. Attach each body with three screws and lock washers.
7. Install electric switch (12) to switch body with two attaching screws. Tighten screws snug only. Place valve selector handle to rear door open-position, then press switch in toward switch plunger until a click-sound in switch is heard. Tighten switch attaching screws firmly. A click-sound in switch should be heard when selector handle is returned to center position.

LEAKAGE TEST

Apply air pressure to inlet port then apply soapy water to each closed exhaust port. Rotate



1 Cover Assembly
2 Handle Shaft
3 Plunger
4 Shim Washer
5 Cam Plate
6 O-ring Seals
7 Valve Assembly
8 Valve Body
9 Manifold Gasket
10 Manifold
11 Valve Spring
12 Electric Switch
13 Plunger Spring
14 Switch Plate
15 Switch Body
16 Index Plunger
17 Plunger Spring
18 Set Screw

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Figure 5—Sectional View of Door Control Valve

valve selector handle to check each port. Disassemble and correct cause of leakage if necessary.

DOOR SWITCHES AND RELAY

Door switch, mounted in each door engine compartment (figs. 1 and 2), is actuated by door operating mechanism. As front door starts to open, striker plate, welded to connecting rod, releases switch plunger, closing contacts of switch. Switch contacts at rear door are closed when lock cam lever is moved to door unlocked position.

Front door switch turns stepwell light and light over door on. Rear door switch energizes operating coil of rear door switch relay, which in turn completes circuit to rear door unlock light over door, the rear door tell-tale, and the interlock magnet valve when rear doors are unlocked. Refer to "Door Control Wiring Diagram" (fig. 24) for switch circuits. For information on rear door switch relay refer to "WIRING AND MISCELLANEOUS ELECTRICAL" (SEC. 7) of this manual.

FRONT DOOR SWITCH ADJUSTMENT

With circuit to door switch energized and doors closed, lights should not be illuminated. Lights should come on just as door starts to open. Relocate switch in bracket by repositioning attaching lock nuts. Tighten lock nuts firmly after making adjustment.

REAR DOOR SWITCH ADJUSTMENT

With circuit to door switch energized and the lock solenoid energized, locate switch in mounting bracket to cause interlock application and the door telltale and light on door compartment cover to illuminate when lock cam lever is moved to unlocked position. Tighten switch mounting nuts firmly after making adjustment.

FRONT DOOR ENGINE

Door engine (fig. 6) is mounted in compartment directly over door (fig. 1).

OPERATION

NOTE: Key numbers in text refer to figure 6.

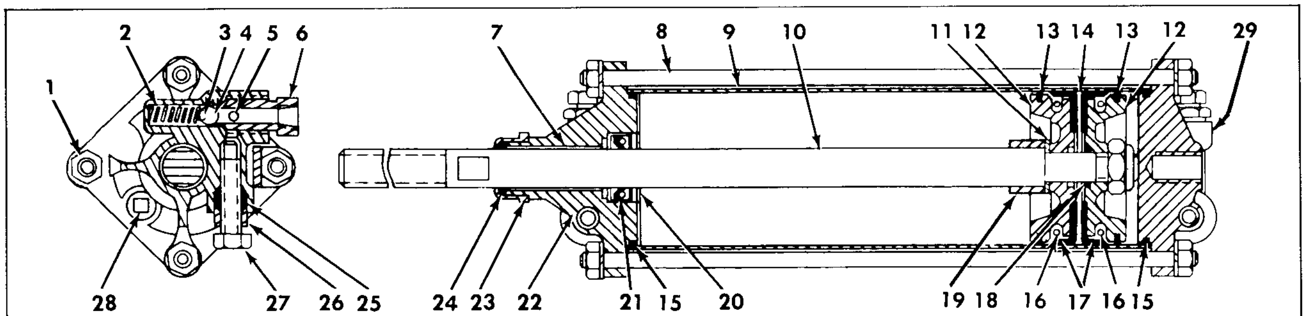
Door control valve admits air to one side of piston, while at same time exhausting pressure from other side of piston.

Air, admitted by control valve, enters adapter (6) where some flows through exhaust port (5) and through passage restricted by metering screw (27), into cylinder. Most of the air flows into cylinder through inlet port (3) after unseating check valve ball (4).

Exhausting air, however, can leave cylinder only past metering screw needle and through exhaust port (5), since inlet passage is closed by check valve ball (4). Consequently, adjustment of metering screw affects only exhausting air.

SPEED ADJUSTMENT (Fig. 6)

Operating speed of door engine is controlled by a metering screw (27) at each end of engine. Screw meters exhausting air only; therefore screw in piston rod end controls opening speed of door and screw at fixed end controls closing speed.



1 Clamp Bolt Nut
2 Check Valve Spring
3 Inlet Port
4 Check Valve Ball
5 Exhaust Port
6 Adapter
7 Piston Rod Bushing
8 Clamp Bolt
9 Cylinder
10 Piston Rod
11 Special Washer
12 Piston Follower
13 Felt
14 Piston Center Plate
15 O-ring Gasket
16 Cup Expander Spring
17 Piston Cup
18 Rod O-ring Seal
19 Piston Stop Sleeve
20 Air Seal Washer
21 Air Seal
22 Front Cover
23 End Cap
24 Felt Washer
25 Metering Screw Seal
26 Metering Screw Lock Nut
27 Metering Screw
28 Lubrication Plug
29 Rear Cover

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Figure 6—Front Door Engine, Also Rear With Folding Doors

1. Loosen lock nut (26), then turn screw (27) into bottom.
2. While operating engine, turn screw out (counterclockwise) until desired speed is obtained.
3. Tighten nut (26) only enough to stop air leakage; overtightening may crack casting.

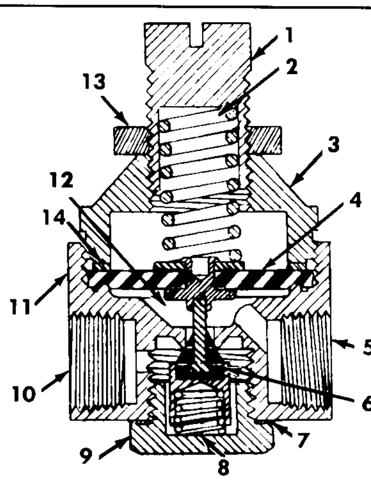
REMOVAL AND DISASSEMBLY

NOTE: Key numbers in text refer to figure 6.

1. Turn air shut-off valve at left of driver to "OFF" position, then disconnect and remove two air lines to engine.
2. Loosen lock nut on end of piston rod; then unscrew yoke end from piston rod.
3. Remove nuts from clamp bolts (8) and remove bolts.
4. Remove end covers (22 and 29) and withdraw piston from cylinder (9).
5. Remove end cap (23) and felt washer (24) from front cover (22).
6. Remove adapter (6) from covers, catching ball (4) and spring (2) in hand.
7. Loosen nut (26); then unscrew metering screw (27). Remove metering screw seal (25).
8. Unscrew nut from piston rod and remove piston parts from rod.

CLEANING AND INSPECTION

Clean all parts thoroughly, then inspect cylinder walls and piston cups. Replace damaged or worn parts.



1 Adjusting Screw
2 Adjusting Spring
3 Valve Cap
4 Diaphragm
5 Outlet Port
6 Valve Assembly
7 Plug Gasket
8 Valve Spring
9 Plug
10 Inlet Port
11 Valve Body
12 Diaphragm Chamber
13 Adjust Screw Nut
14 Washer

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Figure 7—Front Door Air Pressure Regulator Valve

ASSEMBLY AND INSTALLATION

NOTE: Key numbers in text refer to figure 6.

1. Install check valve spring (2), ball (4), and adapter (6) in each cover; then install seal (25), nut (26), and metering screw (27). If air seal (21) was removed from front cover, make sure seal is properly positioned. Install air seal washer (20) and retain in cover by staking in three places. Install new O-ring seal (15) on each cover. Install felt washer (24) and end cap (23) on front cover.
2. Install cup expander springs (16) in groove of piston followers (12). In follower (12) which is last to be installed, place new O-ring seal (18) in counterbore of follower. Place special washer (11) on piston rod, then install followers (12) piston cups (17), and piston center plate (14) on rod. Retain parts in place with rod nut.
3. Apply thin coat of lubricant to piston rod; then insert piston rod with piston stop sleeve (19) installed on rod, through air seal and bushing in front cover.
4. Apply light coat of SAE 10W engine oil to piston and inside of cylinder; then insert piston in cylinder.
5. Position rear cover to cylinder (9). NOTE: Make sure O-ring seals (15) seat in cover grooves.
6. Position clamp bolts (8) through covers. Start nuts and washers on bolts.
7. Tighten nuts alternately and evenly.
8. Remove lubrication plugs (28) from each end cover. Insert 1/2 ounce of SAE 10W engine oil in each end of cylinder. Install plugs then operate piston by hand several times. Turn piston, while operating, to insure even distribution of oil.
9. Test on bench by applying 25 pounds air pressure to one adapter (6) while noting leakage from other adapter. Check opposite end in same manner. Leakage, if any, should be slight. With pressure applied, coat joint of cover and cylinder with soapsuds to check leakage.
10. Install yoke end on piston rod.
11. Install engine into compartment.
12. Install air lines to engine.
13. Adjust linkage as directed later under "Front Door and Linkage Adjustment." Turn air shut-off valve to "ON" position.

FRONT DOOR AIR PRESSURE REGULATOR VALVE

Pressure regulator valve (fig. 7), connected in air system is mounted in back of driver's control panel (fig. 4). Valve regulates air pressure (45 psi) to front door engine. Adjustment of valve is described later under "Air Pressure Adjustment."

OPERATION

NOTE: Key numbers in text refer to figure 7.

Air, entering inlet port (10) flows past valve

stem into diaphragm chamber (12). As pressure increases to valve setting, diaphragm (4) is raised against pressure of adjusting spring (2), permitting valve spring pressure to seat valve (6). Any pressure drop in chamber (12) will cause diaphragm to unseat valve, permitting further flow of air into diaphragm chamber.

TEST

1. Exhaust air pressure from system; then open driver's control panel for access. Connect test gauge in place of outlet line; then loosen knurled lock nut.

2. Build up pressure in system while noting reading of gauge. If pressure gradually increases beyond valve setting, valve is not seating properly. Cause is probably dirt on valve or seat, or worn valve.

3. Apply soap suds around knurled lock nut. If bubbles appear, diaphragm is leaking and must be replaced.

4. If tests show valve to be operating properly, exhaust pressure from system, disconnect gauge and connect outlet line. Build up pressure in system; then adjust valve, as described below under "Air Pressure Adjustment."

5. If tests show valve to be defective, remove for repair.

AIR PRESSURE ADJUSTMENT

NOTE: Access to valve for adjusting is through hole in trim panel at left of driver.

1. Using a 3/4 inch socket wrench, loosen lock nut on valve and back off adjusting screw, using large screwdriver, until pressure is insufficient to open both doors completely.

2. Turn adjusting screw in slowly until doors open completely (approx. 45 pounds). Tighten knurled lock nut firmly.

REMOVAL

1. Exhaust air pressure from line to valve.

2. Remove trim panel at left of driver over valve assembly.

3. Disconnect lines at each end of valve, then remove valve.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 7.

1. Unscrew plug (9) and remove valve (6), with spring (8).

2. Remove adjusting screw (1), with lock nut (13) and remove adjusting spring (2).

3. Unscrew cap (3) from body (11) and remove diaphragm (4) and washer (14).

4. Clean metal parts in suitable solvent and wipe dry. Wipe diaphragm and valve clean with cloth dampened with cleaning solution.

5. Examine diaphragm and valve carefully. Replace, if parts are not in good condition.

ASSEMBLY

NOTE: Key numbers in text refer to figure 7.

1. Position diaphragm (4) and washer (14) in body (11); then screw cap (3) into body.

2. Position adjusting spring (2) in cap; then start screw (1) with lock nut (13) in cap.

3. Position valve spring (8) and valve (6) in plug (9). Install plug with gasket (7) in body, tightening plug firmly.

4. Adjust valve to 45 pounds pressure, using gauge connected to valve outlet.

INSTALLATION

Valve must be connected so that air flow is in direction of arrow stamped on side of valve. NOTE: Arrow should point upward as shown in figure 4. Reversed installation will result in slow action of doors with full system pressure, and slamming of doors at low system pressure.

After installation, adjust valve setting as described earlier under "Air Pressure Adjustment."

REAR DOOR CHECK CYLINDER

Rear door check cylinder (fig. 8) is installed in compartment above door (fig. 2). When doors are pushed open, air is forced from cylinder past check ball in speed control valve mounted at pivot end of cylinder. As doors close, air is drawn into cylinder, past the speed adjustment needle of the speed control valve. Control valve meters the incoming air to control speed of closing door.

MAINTENANCE

Check cylinder should be disassembled and internal parts lubricated annually. External lubrication of push rod can be accomplished by applying 2 to 3 drops of clean engine oil to push rod when doors are closed.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 8.

1. Mark both front and rear covers (3 and 15) in relation to cylinder tube (7) to assure proper positions of parts at reassembly.

2. Remove nuts and washers from four tie-bolts (17) which retain cylinder assembly together. Remove tie-bolts and separate tube (7) and covers. Pull push-rod (8) and piston from tube.

3. Mark position of eye (13) and lock nut (12) on push rod, then remove eye and lock nut. Remove push rod from front cover.

4. Remove O-ring seals (4) from groove in front and rear covers.

5. Turn piston follower (22) from push rod, then remove piston cup (21), cup expander (20),

piston (18), and washer (6) from push rod. Remove O-ring seal (5) from counterbore in piston and remove seal (19) from groove in piston.

6. Pry seal cap (11) with seal (14) from front cover (15). Remove seal from cap.

7. If bushing (10) is worn excessively, press from front cover. Remove washer (9) from cover.

CLEANING AND INSPECTION

NOTE: Key numbers in text refer to figure 8.

Wash all parts in cleaning solvent. Press felt parts dry. Examine all parts for wear, giving particular attention to piston cup. O-ring seals (4 and 5), felt seals (14 and 19), and push rod bushing (10) in front cover. If worn, replace.

ASSEMBLY

NOTE: Key numbers in text refer to figure 8.

1. Coat inner wall of cylinder tube (7) with thin film of chassis lubricant.

2. If bushing (10) was removed from front cover (15), press new bushing flush in cover, then burnish to size which will allow free movement of push rod.

3. Install felt seal (14) in seal cap (11). Press cap on front cover (15). Install washer (9) into counterbore at inner side of front cover.

4. Install O-ring seal (5) into counterbore of piston (18) and install seal (19) in outer groove of piston.

5. Referring to illustration, install washer (6), piston (18), cup expander (20), piston cup (21), and follower (22) on push rod (8) as shown. Tighten follower firmly on rod.

6. Install O-ring seals (4) in grooves of front and rear covers (3 and 15).

7. Insert end of push rod (8) through front cover (15) then install eye (13) with lock nut (12) on push rod to mark made prior to disassembly. Tighten lock nut firmly.

8. Being careful not to damage piston cup (21), force push rod with piston parts through cylinder tube (7).

9. Align rear cover (3) with tube and front cover to marks made prior to disassembly, then install tie-bolts (17). Tighten bolt nuts evenly and firmly.

10. Force push rod in and out to check for binding or any restriction. Install closing speed control valve to rear cover with adjustment screw at top side. Install eye rod with lock nut to rear cover.

FRONT DOORS AND LINKAGE ADJUSTMENT

NOTE: Refer to figure 1 which illustrates door linkage shown in door-closed position.

1. Exhaust air pressure from system by placing door shut-off valve lever in "OFF" position.

2. Check door rear lever angle position on door shaft. Door rear lever angle position should be as shown in figure 1. If checks necessitates adjustment, loosen clamp bolt, then rotate lever to specified angle. After making adjustment, tighten clamp bolts to 45 to 50 foot-pounds torque.

3. With doors still closed, check position of

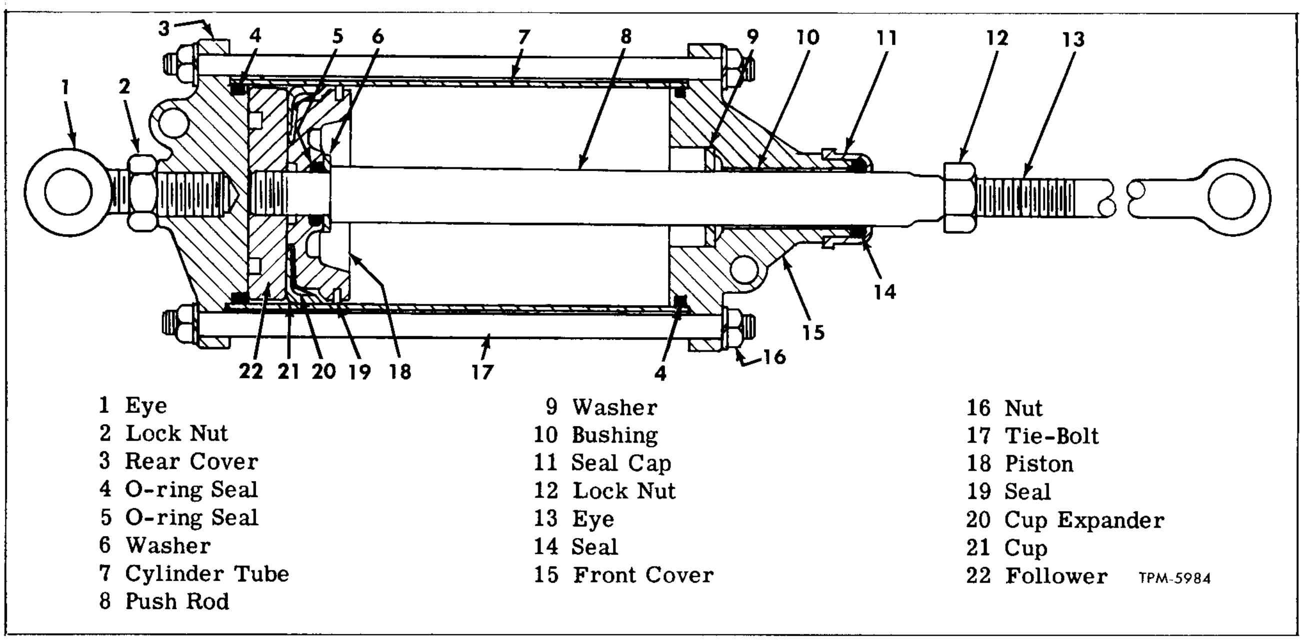


Figure 8—Rear Door Check Cylinder—Push Type Doors

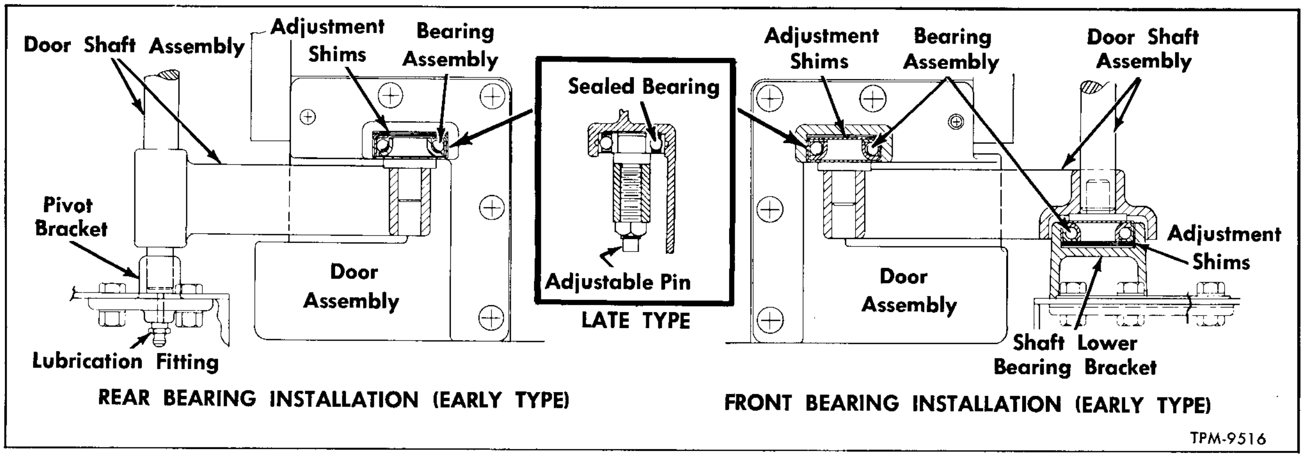


Figure 9—Front Door Lower Pivot Bearings Installed

idler lever which should be located at a 43° angle. Disconnect and lengthen or shorten connecting rods to obtain correct idler lever angle. Adjust rods as necessary to provide free pins. Operate doors by hand to check adjustment.

4. With doors completely closed, and piston in door engine fully retracted, adjust length of door engine and engine rod to a dimension 1/8 inch shorter than distance between lever pin center and idler lever pivot bolt. Install engine and yoke pins with anti-rotation retainers on each pin. Operate doors by hand to check travel to complete closed and open positions. If operation is satisfactory, operate doors using air pressure. Make sure doors open and close completely. Tighten engine rod lock nut firmly after making final adjustment.

5. Height of door halves in coach opening is adjustable (fig. 9). On early type, shims are provided at locations shown; on latest type a threaded adjustable pin is used at locations indicated.

REAR DOORS AND LINKAGE ADJUSTMENT

NOTE: Key numbers in text refer to figure 2.

1. Block or clamp doors in closed position.

2. Check angle position of levers (21) on door shafts. Levers should be clamped to door shaft at a 45° angle as shown. If lever angles are to be changed, disengage door return spring (8) before making change. Disconnect piston rod eye (6) from check cylinder lever (7). This will allow for making linkage adjustment more freely. Disengage connecting rods (14 and 19) at lever end, then re-clamp levers to rods at specified angle. Tighten clamp bolts to 45 to 50 foot-pounds torque after making adjustment.

3. Install connecting rods to levers. Loosen turnbuckle lock nut, then rotate turnbuckle until yoke pin can be installed.

NOTE: Dimension from centers of connecting rod yoke pins should be approximately 13-15/16".

4. Limit door full open travel to 90 degrees from closed position by door stop screw (18). After adjusting stop, tighten screw lock nut firmly.

5. NOTE: With doors in completely open position and piston against rear cover, the check cylinder rod eye (6) should drop freely over pin of check cylinder lever (7). If this is not possible, loosen cylinder rod lock nut (5) and turn rod eye (6) in or out of cylinder rod (4) as necessary to obtain adjustment. Flats on cylinder rod are for wrench while making adjustment.

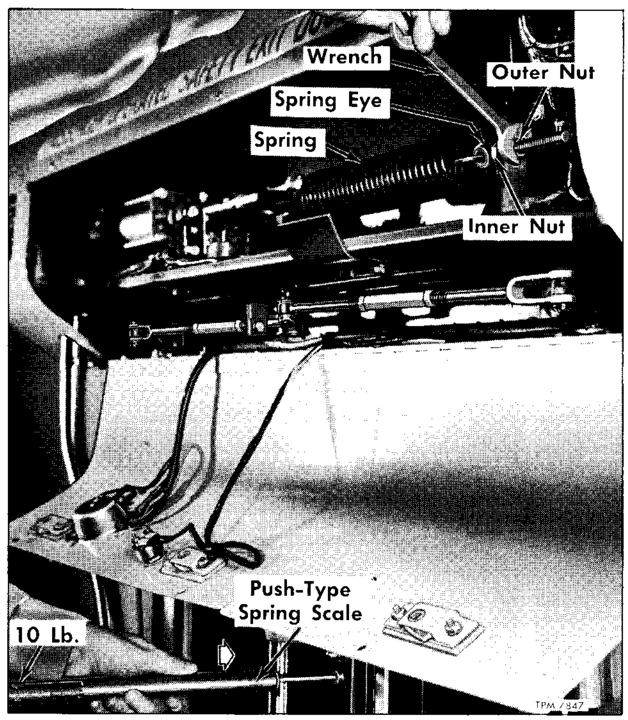


Figure 10—Adjusting Push Type Rear Door Return Spring Tension

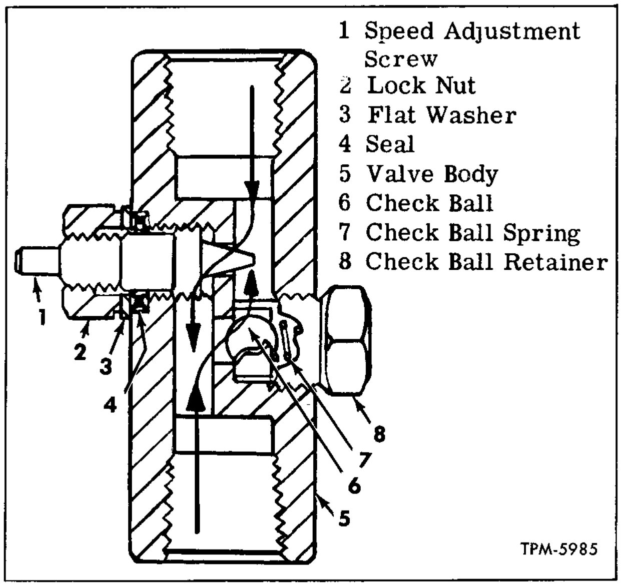


Figure 11—Rear Door Closing Speed Control Valve

6. If linkage adjustment is satisfactory, connect door return spring (8). Adjust return spring tension at threaded eye-end (11) of spring. Adjust spring so that a tension checking scale registers 10 lbs. on door inner edge to open door (fig. 10).

7. Retain doors closed, then check door lock cam (28) to lock cam lever catch. NOTE: To assure complete locking of door, a tight locking adjustment is not recommended. A 1/32" clearance "B" is recommended between lock lever and cam notch. Adjustment is made by slight adjustment of one or both connecting rods.

8. Correct clearance "A" between lock solenoid cap (24) and lock cam lever adjustment screw (25) should measure 1/8 inch with doors in locked-closed position. If necessary to change adjustment, loosen screw lock nut and turn screw (25) to obtain 1/8 inch clearance. Tighten lock nut after making adjustment.

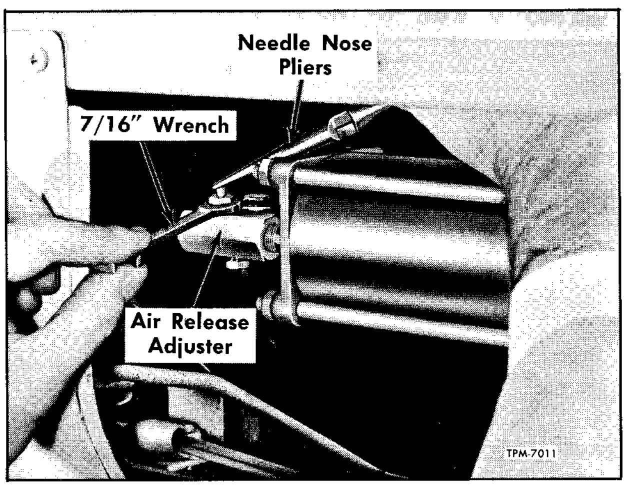


Figure 12—Adjusting Rear Push-Type Door Closing Speed

REAR DOOR CLOSING SPEED CONTROL VALVE

Rear door closing speed control valve (fig. 11), mounted to pivot end of door check cylinder serves to control closing speed of door. Valve is constructed as shown. Air flow through valve is explained previously under "Description and Operation" - "Rear Doors."

SPEED CONTROL ADJUSTMENT (Fig. 11)

Adjust metering to cushion door on closing by loosening lock nut (2) then turning speed adjusting screw (1) as shown in figure 12. Turning screw clockwise increases cushion effect or turning screw counterclockwise lessens cushion effect. Adjust to prevent door slamming. Tighten adjustment screw lock nut firmly after making adjustment.

DISASSEMBLY (Fig. 11)

1. Remove lock nut (2) then turn speed adjusting screw (1) with nut, flat washer (3), and seal (4) from valve body (5).

2. Remove check ball retainer (8) from valve body. Remove check ball (6) and spring (7).

CLEANING AND INSPECTION

Clean all parts in a cleaning solvent, then inspect check ball for pitted condition and inspect ball seat in valve body for worn condition. If either condition exists, replace complete valve assembly.

Examine speed adjustment screw for grooved condition at needle and also check for worn condition of needle seat in valve body. Replace entire assembly if either condition exists.

ASSEMBLY (Fig. 11)

1. Install check ball (6) check ball spring (7) and retainer (8) into valve body (5). Tighten retainer firmly.

2. Assemble seal (4), flat washer (3), and nut (2) on speed adjustment screw (1), then thread screw into valve body. Turn screw in until screw contacts seat lightly, then back off screw 1/4 turn. Tighten lock nut. Install valve assembly with arrow on valve pointed toward check cylinder, then make speed adjustment as described previously under "Speed Control Adjustment."

REAR DOOR LOCK SOLENOID

Lock solenoid is used to disengage door lock cam lever from notch of door lock cam whenever driver places control lever in door unlock position.

SOLENOID MAINTENANCE

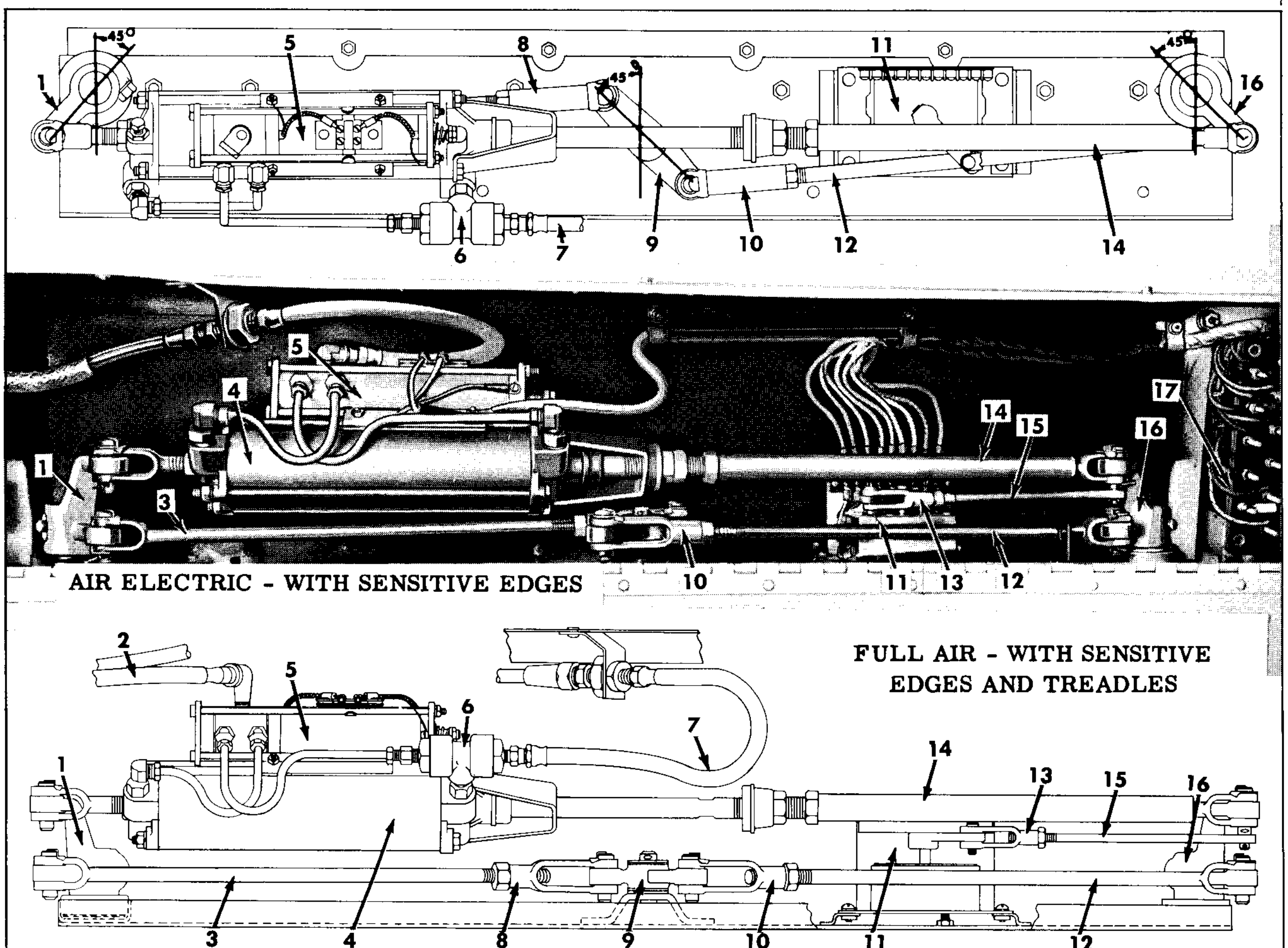
Solenoid requires no periodic maintenance other than keeping the terminals clean and tight. Always check action of solenoid if it has been removed. If unit fails to function, first check wiring before condemning the solenoid. Solenoid winding can readily be checked for current draw, open circuit, or shorts.

Refer to "Door Control Wiring Diagram" (fig. 24) for wiring circuits.

SPECIAL CONTROLS AND DOORS

Following pages contain information on doors and controls available as special equipment. As special equipment, many coaches are equipped with outward folding four leaf rear doors, sometimes called "jack-knife type." Controls for this type door is illustrated in figure 13.

In addition to special doors, coaches are usually equipped with one or more safety devices such as accelerator and brake interlocks, sensitive edge door reversing mechanism, treadles, and rear door emergency release.



1 Door Lever - Front
2 Air Line - Closing
3 Connecting Rod - Front
4 Door Engine
5 Solenoid Valve
6 Double Check Valve
7 Air Line - Opening
8 Adjustable Yoke - Front
9 Connecting Rod Idler Lever
10 Adjustable Yoke - Rear
11 Door Cam Switch
12 Connecting Rod - Rear
13 Adjustable Yoke - Cam Switch
14 Door Engine Rod
15 Cam Switch Rod
16 Door Lever - Rear
17 Wiring Junction Block

TPM-9509

Figure 13—Rear Door Engine and Linkage—Four Leaf Folding

FOLDING REAR DOORS

Operation of four leaf folding "jack-knife" doors is similar to standard push-type doors previously covered in this section, that is, each is controlled by the operator and use "full air" or "Air-electric." Typical air-electric door operating mechanism is shown in figure 13.

DOOR ENGINE

Rear door engine, used with folding doors, is the same type as illustrated in figure 6, therefore information previously given under heading "Front Door Engine" is also applicable to door engine used with rear folding doors.

DOOR LINKAGE ADJUSTMENT

Whenever it becomes necessary to adjust linkage due to new parts being installed or if adjustments have been disturbed, proceed as follows:

1. Close doors completely.
2. Check angle of front and rear door levers to be sure they are set at 45° angle (fig. 13). If necessary, loosen clamp bolt and reset lever to proper angle and re-tighten clamp bolt to 45-50 foot-pounds.
3. With doors completely closed install forward and rearward connecting rods to idler lever and front and rear levers. Adjust rods as necessary to provide free pins, then operate doors by hand to assure proper adjustment. Door levers and idler lever must travel an equal amount on either side of center.
4. With doors still closed connect engine to door front lever, then extend door engine and adjust rod to 1/4" greater than distance between front and rear levers. Collapse engine sufficiently to install clevis pin.

DOOR ENGINE SOLENOID VALVE

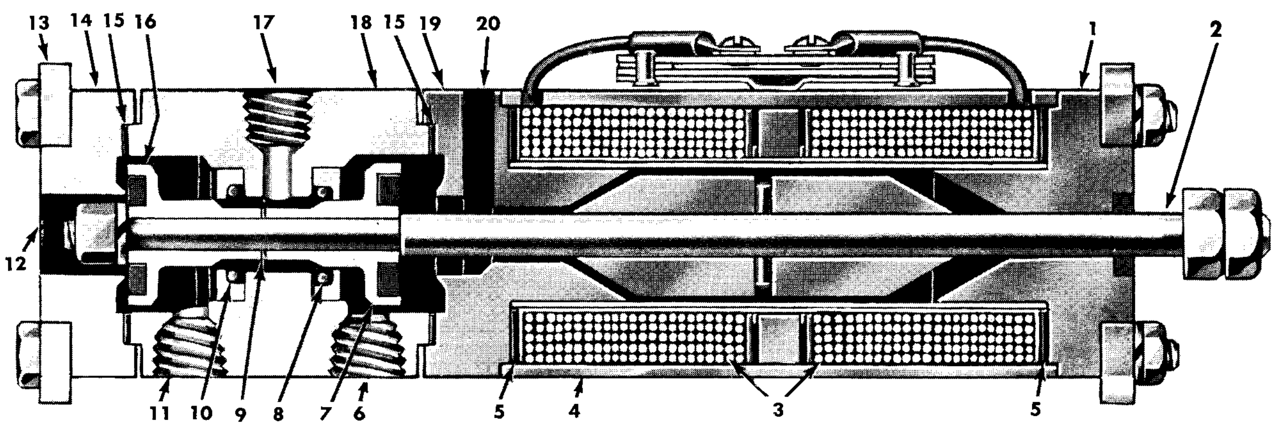
Solenoid valve consists of two intake valves and two exhaust valves, actuated by a dual solenoid (fig. 14). Solenoid coils are alternately energized by movement of door sensitive edge switch or by driver's control valve, with resultant valve action admitting air to one side of door engine, while exhausting air from other side.

OPERATION

NOTE: Key numbers in text refer to figure 14.

In position shown in figure 14, exhaust valve (16) is closed, pressure valve (10) is open, exhaust valve (7) is open, and pressure valve (8) is closed. Consequently, air entering pressure port (17) flows through open valve (10), into that end of door engine connected to cylinder port (11). At the same time, pressure in that end of cylinder connected to cylinder port (6) is exhausted past valve (7) and out exhaust port (20).

If right-hand solenoid coil (3) is now energized, shaft (2) begins moving to right. After initial movement begins, effect of air pressure is sufficient to complete movement of shaft. Consequently,



1 Solenoid End Plate
2 Shaft
3 Solenoid Coil
4 Solenoid Shell
5 Rubber Washer
6 Cylinder Port
7 Exhaust Valve
8 Pressure Valve
9 Spacer
10 Pressure Valve
11 Cylinder Port
12 Exhaust Port
13 End Plate
14 Valve Seat Head
15 Gasket
16 Exhaust Valve
17 Pressure Port
18 Control Body
19 Body to Solenoid Spacer
20 Exhaust Port

TPM-9499

Figure 14—Rear Door Engine Solenoid Valve

solenoid coil need not be energized during entire movement of shaft.

When shaft completes movement, valve (7) is seated, while valve (8) is opened, thus permitting flow of air into end of cylinder connected to port (6). At same time, valve (16) is unseated, while valve (10) closes, permitting air from end of cylinder connected to port (11) to exhaust through port (12).

TEST ON VEHICLE

If solenoid appears to operate improperly check air pressure applied to the valve and then the solenoid coils and wiring as follows:

1. A test light or voltmeter connected between each terminal and ground while the control switch is operated in both positions will indicate current supplied to the coils. If test indicates that current is present at the solenoid terminals during the various positions of the door control switches, proceed as follows in step 2.

2. Disconnect feed wires from the solenoid and test for continuity of the coils either with a 9 ampere fuse in series with each coil while it is energized or with an ohmmeter. If the fuse flows (shorted coil) or abnormal resistance is indicated (2.2 to 2.3 ohms normal) the coil is defective. If the fuse does not blow an ammeter may be used to indicate current draw of the coil (3.8 to 4.0 amperes @ 12V). A test light connected between the feed wires and the coils will indicate continuity of the coil but will not detect an internally shorted coil. The location of a short can be determined only by either the resistance or current draw methods. With the exception of the resistance test the door switches must be operated in the normal manner during tests. Low current draw will indicate either high resistance in the coil circuits or excessive voltage drop across the switches, circuit breaker or defective wiring.

3. Remove clamps, which attach solenoid valve to door engine; then remove valve.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 14.

1. Coils may be tested on bench, to determine necessity for replacement, in same manner as described under "Test on Vehicle," earlier.

2. Mark valve sections with punch to facilitate alignment at assembly.

3. Remove two nuts (if used) from end of shaft (2). Remove nuts and lock washers; then remove four long bolts. Slide end plate, solenoid end plate (1), and solenoid shell (4) from shaft (2). Coils can now be replaced without further disassembly of unit.

4. Remove end plate (13) and seat head (14).

5. Clamp solenoid plunger flats in vise. Unscrew nut from shaft; then slide exhaust valve (16) and control body (18) from shaft. Remove remaining valve (7) with spacer (9) from shaft; then remove body and solenoid spacer (19), with gasket (15).

INSPECTION

NOTE: Key numbers in text refer to figure 14.

1. Wipe parts with clean, soft cloth. Use solvent, if necessary, only on all-metal parts.

2. Examine valve seat surfaces of valve seat head (14) and solenoid spacer (19). Make sure seats are clean and free from nicks.

3. Insert valves (7 and 16) into O-rings (8 and 10) in control body (18). Valves must be a slide fit in rings. Replace O-rings, if cut or damaged.

4. Polish solenoid plunger with fine emery cloth and wipe clean.

ASSEMBLY

NOTE: Key numbers in text refer to figure 14.

1. Clamp flats of solenoid plunger in vise, with small end of shaft at top.

2. Referring to illustration, install solenoid spacer (19), new gasket (15), valve (7), spacer (9), control body (18), and valve (16). Install lock washer and nut, tightening nut firmly.

3. Install new rubber washer (5) on each end of solenoid shell (4). Insert shaft through solenoid body and position solenoid end plate over shaft and into solenoid body.

4. Install end plate; then install two nuts on end of shaft, locking outer nut firmly against inner.

5. Install gasket (15) in valve seat head (14) and position head to control body (18). Position end plate (13) to head and install four long bolts through end caps.

6. Install lock washers and start nuts on tie bolts. Align punch marks, made at disassembly; then tighten four nuts alternately and evenly.

INSTALLATION

1. Position valve on door engine; then install mounting clamps. Do not tighten clamps.

2. Connect air lines between valve and door engine. Connect air supply hose to top of valve. Tighten mounting clamps firmly.

3. Connect wires to proper leads, according to markings made at removal.

4. Turn air valve, at left of driver, counterclockwise, to operating position.

INTERLOCKS

Interlocks, brake and accelerator, are employed as safety devices to prevent movement of coach while exit door is open and passengers are alighting.

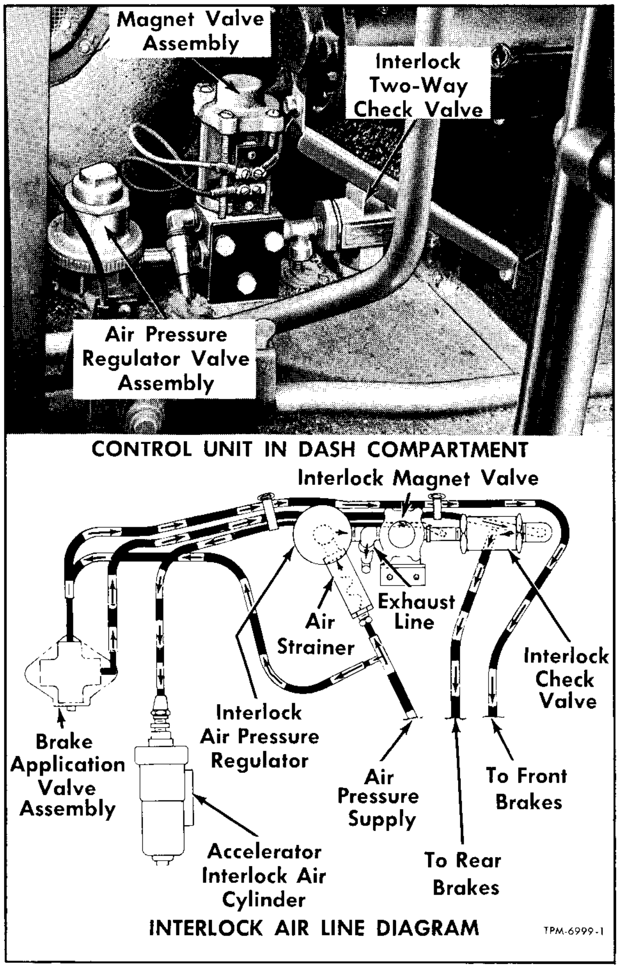
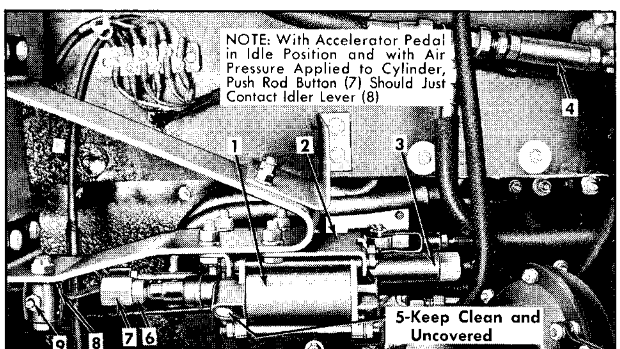


Figure 15—Brake and Accelerator Interlock Mechanism and Air Lines Installed In Dash Compartment



1 Interlock Cylinder Assy.
2 Interlock Mounting Bracket
3 Interlock Accelerator Linkage Spring Assy.
4 Air Strainer Assy.
5 Cylinder Breather (KEEP CLEAN)
6 Lock Nut
7 Push Rod Button
8 Accelerator Linkage Idler Lever
9 Lubrication Fitting

TPM-6957-1

Figure 16—Accelerator Interlock Linkage

BRAKE INTERLOCK

Brake interlock is connected to the door controls and functions to supply air pressure to the rear brakes, thus applying brakes, whenever doors are open. To prevent throwing vehicle into a skid by accidentally opening doors and thus applying rear brakes while vehicle is in motion; full air pressure is not applied. Instead, pressure is reduced to 35-40 pounds by means of a pressure regulating valve.

OPERATION

Operation of interlock is automatic and driver has no direct control. However, if failure in door control electrical system causes interlock to apply brakes, driver may shut off door electrical circuits at door master switch. Switch is located on recessed switch panel at left of driver. Turning switch off should release interlock pressure from brakes; if pressure does not release, do not operate coach.

MAINTENANCE

The brake interlock consists of door switches and wiring, air strainer, pressure regulating valve, interlock magnet valve, and double check valve (fig. 15).

Electrical circuits are shown on "Door Control Wiring Diagrams" (figs. 25 and 26).

ACCELERATOR INTERLOCK

Accelerator interlock is employed in connection with brake interlock and is connected to rear doors only.

Interlock functions to prevent engine exceeding idling speed when rear doors are unlocked. Interlock air cylinder (fig. 16) is supplied with full reservoir air pressure through interlock magnet valve (fig. 15). A single magnet valve supplies air pressure to both brake and accelerator interlocks. Accelerator interlock air cylinder is mechanically connected to accelerator control rod when air pressure is applied to cylinder.

Driver has no direct control of accelerator interlock, since operation is automatic. However, if failure in door control electrical circuits causes accelerator interlock to function, driver may shut off door electrical circuits at door master switch.

Repair information on the various interlock units, is explained below under respective headings.

Figures 24, 25, and 26 illustrate interlock units installed in system.

ACCELERATOR INTERLOCK AIR CYLINDER

MAINTENANCE

Interlock air cylinder should be removedfrom coach annually for inspection and lubrication.

DISASSEMBLY AND ASSEMBLY OF INTERLOCK AIR CYLINDER

NOTE: Key numbers in text refer to figure 17.

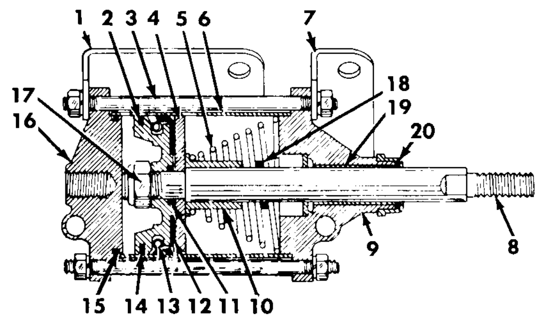
1. Mark both front and rear covers in relation to cylinder tube to reassure proper position of parts at reassembly.
2. Remove four nuts which attach front bracket (7) to front cover (9). Remove bracket. Pull front cover with push rod assembly from cylinder tube (6).
3. Pull cylinder tube (6) from rear cover (16). Remove O-ring gasket (15) from rear cover.
4. Remove nut (17) from push rod (8), then pull piston parts and return spring (5) from push rod. Remove O-ring gasket (11) from piston follower (2). Remove felt (14) from piston follower (2).

NOTE: Further disassembly of cylinder is generally not necessary.

5. Wash all parts in solvent, then carefully examine parts for signs of wear, giving particular attention to piston cup (12) and gaskets (11 and 15). Replace worn parts as necessary.
6. Coat entire inside wall of cylinder tube (6) with a light film of chassis lubricant.
7. Place piston rod washer (18) on piston rod. With front cover (9) on push rod, position return spring (5), piston stop spacer (10), and piston plate (4) on push rod.
8. Install O-ring seal (11) into counterbore of piston follower and felt (14) into groove of follower. Place cup expander spring (13) and piston cup (12) over follower. See illustration for position of parts.
9. Install follower with piston cup on push rod and retain with nut. Tighten nut firmly.
10. Install O-ring gasket (15) into groove of rear cover (16).
11. Being careful not to damage piston cup (12), install cylinder tube (6) over piston parts.
12. Apply engine oil to felt seal in front cover then assemble front and rear covers to cylinder tube with location marks made prior to disassembly aligned. Install tie-bolts (3) and mounting brackets (1 and 7). Tighten tie-bolt nuts evenly and firmly. If push rod end yoke was removed, reinstall.

INTERLOCK LINKAGE ADJUSTMENT

Linkage at front of coach is accessible from underneath coach (fig. 16). When door control valve is placed in any door unlocked or open position,



1 Rear Bracket	*11 Rod O-ring Gasket
2 Piston Follower	*12 Piston Cup
3 Tie-Bolt	13 Cup Expander Spring
4 Piston Plate	*14 Piston Felt
5 Return Spring	*15 Cover O-ring Gasket
6 Cylinder Tube	16 Rear Cover
7 Front Bracket	17 Push Rod Nut
8 Push Rod	18 Piston Rod Washer
9 Front Cover	*19 Bushing
10 Piston Stop Spacer	*20 Felt Washer

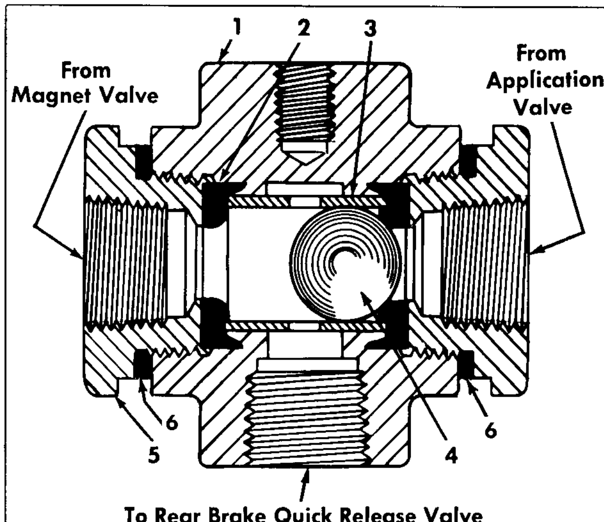
*Part of Repair Kit. TPM-7004

Figure 17—Accelerator Interlock Air Cylinder Assembly

air pressure is applied to the interlock air cylinder which in turn forces accelerator linkage to the idle position.

Interlock linkage is properly adjusted when the following three conditions occur:

a. Accelerator pedal and linkage returns to idle position.



1 Body	3 Sleeve	5 End Cap
2 Seal	4 Ball	6 Gasket

TPM-7003

Figure 18—Interlock Double Check Valve

b. Air pressure is applied to interlock air cylinder (rear doors unlocked).

c. Button (7, fig. 16) just contacts accelerator idler lever (8, fig. 16).

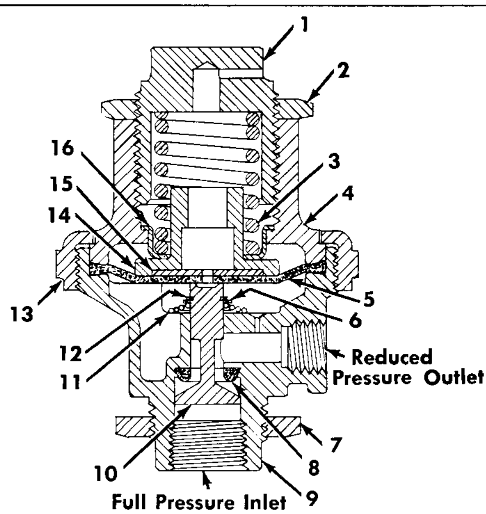
If adjustment is necessary, loosen lock nut (6, fig. 16) and reposition push rod button (7, fig. 16). After making adjustment tighten lock nut firmly.

INTERLOCK DOUBLE CHECK VALVE

Brake interlock double check valve (fig. 18) is installed in air system as shown in figures 24, 25, and 26. Purpose of valve is to direct flow of air pressure from either brake application valve or brake interlock magnet valve into air line leading to rear brake valve. Figure 15 shows valve installed in dash compartment.

OPERATION (Fig. 18)

When brake treadle is depressed, air pressure from application valve forces ball against seal at inlet from magnet valve. Air flows out through holes in sleeve and into air line leading to rear brake valve. With brake treadle released, air pressure from application valve is shut off. When door is unlocked, magnet valve admits air pressure to check valve. Air forces ball against seal at inlet



1 End Plug
2 Cover End Nut
3 Diaphragm Spring
4 Valve Body
5 Diaphragm
6 Valve Spring Washer
7 Valve Mounting Nut
8 Valve Seal
9 Valve Cover
10 Valve Plunger
11 Valve Spring
12 Valve Spring Washer Snap Ring
13 Valve Cover Clamping Ring
14 Diaphragm Support
15 Diaphragm Support Plate
16 Diaphragm Spring Retainer

TPM-4151

Figure 19—Interlock Air Pressure Regulator Valve

from application valve and flows out through holes in sleeve into air line to rear brakes only. It is important that check valve ball seats properly, since any air leakage past ball will escape through open exhaust port of valve (application or magnet) which is not applying brakes.

TEST (Fig. 18)

To check for leakage past valve ball, disconnect air line from magnet valve at check valve. Apply soap suds to open end of check valve and manually apply brakes. Appearance of bubbles indicates leakage. Reconnect air line from magnet valve to check valve using aviation type sealing compound on threaded fitting. Disconnect air line from application valve at opposite end of valve. Apply rear brakes through magnet valve by unlocking rear door and check for leakage indicated by bubbles. If leakage is evident, remove and clean valve. If leakage is not indicated, reconnect air line to valve, using aviation type sealing compound on fitting.

DISASSEMBLY

Check valve is disassembled by unscrewing end cap from each end of valve and removing seals, ball, and sleeve.

INSPECTION (Fig. 18)

Wash all parts, except seals and gaskets, in cleaning solvent and wipe or blow dry. Examine parts and replace with new parts if necessary.

ASSEMBLY (Fig. 18)

Position sleeve and ball in body; then install seals. Position gaskets on end caps; then install end caps in body, tightening caps firmly.

INTERLOCK AIR PRESSURE REGULATOR VALVE

Interlock air pressure regulator (fig. 19) is mounted in dash compartment as shown in figure 4.

Valve regulates air pressure of 35 to 40 psi to the interlock magnet valve. Periodically, pressure permitted through valve should be checked with an air gauge.

CHECKING AIR PRESSURE

Pressure can be checked on bench or on vehicle. When testing on vehicle, temporarily close off air pressure to regulator.

NOTE: Key numbers in text refer to figure 19.

1. Install air gauge in reduced-pressure line fitting or to line to rear brakes or accelerator air cylinder then apply air pressure to valve inlet. Pressure should be 35 to 40 psi.

2. Loosen cover end nut (2) and turn end plug (1) until correct pressure registers on gauge. If

pressure is not correct when check is started, inspect diaphragm (5), and replace as instructed later under "Replacement of Diaphragm."

REPLACEMENT OF DIAPHRAGM

Diaphragm can be replaced without completely disassembling the valve or disturbing pressure adjustment.

NOTE: Key numbers in text refer to figure 19.

1. Cut off source of air supply to regulator by disconnecting full-pressure line.
2. Turn valve cover clamping ring (13) until regulator assembly is separated.
3. The diaphragm (5) is then exposed. Diaphragm support (14) and plate (15) are loose.
4. Replace diaphragm if damaged.
5. Insert the support (14) into spring. Position support plate (15) over diaphragm.
6. Insert valve body (4) through valve cover clamping ring (13). Screw clamping ring over body. Turn firmly. Reconnect full pressure line and make reduced pressure check.

REPLACEMENT OF VALVE

NOTE: Refer to figure 15.

1. Shut off air supply to pressure regulator valve or exhaust pressure from coach air system.
2. Remove dash closure panel, then remove attaching screws retaining mechanism to floor. Prop up mechanism, then disconnect inlet line down through floor. Valve can then be turned from magnet valve nipple.
3. Apply small quantity of sealing compound to threads of line fittings when installing valve. Tighten connections firmly.

DISASSEMBLY OF VALVE

Key numbers in text refer to figure 19.

1. Separate the assembly by unscrewing valve cover clamping ring (13). Diaphragm (5) support (14) and support plate (15) can then be removed.
2. Remove cover end nut (2). Remove end plug (1). Spring (3) can then be removed.
3. If valve plunger (10) or spring (11) must be replaced, remove snap ring (12). Plunger (10), spring (11) and seal (8) can then be removed.

ASSEMBLY OF VALVE

Key numbers in text refer to figure 19.

1. Place plunger (10) and seal (8) into body. Apply a small amount of lubriplate on plunger at assembly.
2. Install spring (11), washer (6), and snap ring (12). Try spring and plunger action.
3. Install spring (3) into end plug (1).
4. Thread end plug into body. Insert diaphragm support (14) into spring.
5. Position diaphragm (5) into place. Place diaphragm support plate over diaphragm.
6. Position valve body and spring assembly over diaphragm. Tighten clamping ring securely.
7. Install cover end nut (2) loosely.
8. Check reduced pressure by attaching air source to full pressure connection and air gauge to reduced pressure fitting.
9. Turn end plug (1) until pressure regulator delivers 35 to 40 psi. Tighten cover end nut (2) after pressure adjustment is made.

INTERLOCK MAGNET VALVE

Interlock magnet valve (fig. 20) is mounted on floor in dash compartment (fig. 15). Actuated by door control valve switch through the switch in compartment above doors, valve applies air pressure to rear brakes and accelerator air cylinder. Purpose of valve is to prevent movement of coach when doors are opened or unlocked. Schematic position of magnet valve in system is shown in figures 24, 25, and 26.

OPERATION

Energized magnet valve admits air, at reduced pressure, to brakes and accelerator interlock cylinder. This action applies brakes and locks accelerator in idling position. When doors close, magnet valve is de-energized. Pressure in brake chambers and accelerator interlock cylinder exhausts through magnet valve, releasing interlock.

MAINTENANCE

Foreign substances, present in compressed air system, may enter magnet valve and damage valve faces and seats sufficiently to permit air

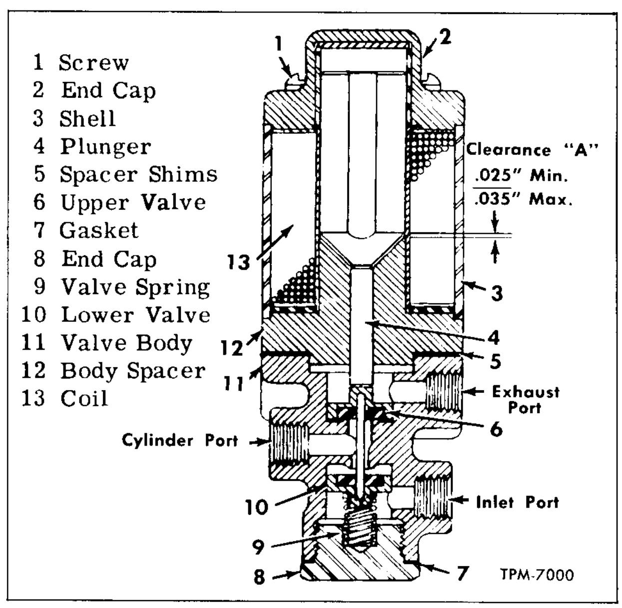


Figure 20—Interlock Magnet Valve

leakage. Magnet valve can readily be tested on vehicle or on bench by applying soap suds and noting if air bubbles appear as valve is operated. A leaking or sticking valve should be immediately removed for repair or replacement.

DISASSEMBLY (Fig. 20)

1. Remove four screws (1) and lift off solenoid coil section being careful to avoid damaging spacer shims (5).

NOTE: Shims should be checked for total thickness to assure proper replacement to maintain clearance "A." See illustration.

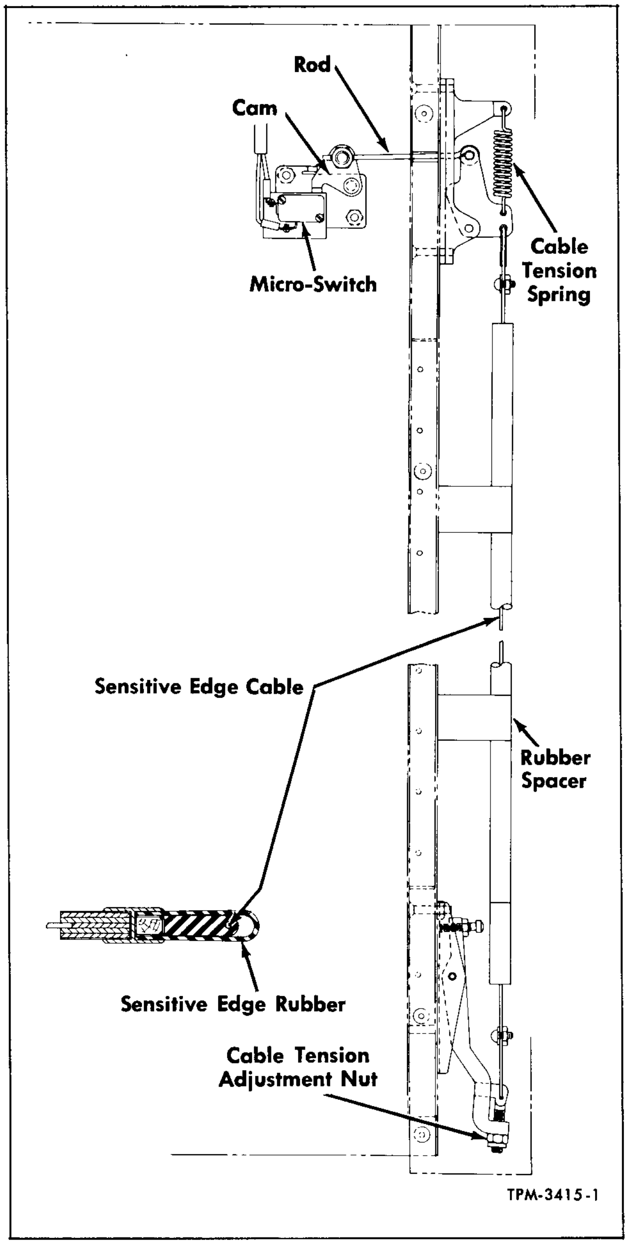


Figure 21—Door Sensitive Edges

2. Remove end plug (8) and spring (9) from valve body (11). Remove upper and lower valves (6 and 10).

3. Wipe, then inspect valves carefully. Replace if worn or damaged.

4. Clean valve body (11) in solvent and blow passages out with compressed air.

5. Remove plunger (4) from solenoid section, clean and wipe dry.

ASSEMBLY (Fig. 20)

1. Place lower valve (10) in valve body (11), add spring (9), gasket (7), and end plug (8). Tighten end plug securely.

2. Place upper valve (6) in body section and place all spacer shims (5) in position. NOTE: Care must be taken that original shims are reinstalled to assure specified clearance "A." Otherwise valve will not operate properly.

3. Position body spacer (12), coil (13), and shell (3) on valve section.

4. Place plunger (4) into position, then install end cap (2). Install four screws (1) with lock washers attaching cap to body. Tighten screws evenly until reasonably snug.

DOOR SENSITIVE EDGES

DESCRIPTION AND OPERATION

Sensitive edges are a safety device, designed to reopen doors in the event they should touch a passenger while closing. Although sensitive edges can be installed on entrance door, most common application is on exit door. Sensitive edges are frequently combined with other special devices, such as brake interlock, accelerator interlock, and treadles.

Sensitive edges incorporate electrical contacts actuated by pressure on rubber edges of doors. Micro-switch, mounted near top of door, is operated by rod. Pressure against sensitive edge deflects vertical cable in edge, operating rod to close micro-switch contacts (fig. 21).

If door closes upon passenger or other obstruction, electrical contact immediately reverses movement of door. Door opens completely, then automatically closes if obstruction has been removed. Otherwise door repeats cycle of partly closing and fully opening until obstruction is removed, or until driver opens door with control switch.

When door closes completely, sensitive edge control of door becomes inoperative. If an object is not inserted between sensitive edges, doors remain closed, but driver is warned of this condition by ringing of bell mounted on dash panel at left of steering column.

Operation of sensitive edges is automatic, and driver has no direct control of this equipment.

However, if failure of electrical control circuits results in improper operation, driver may shut off door safety circuits with door master switch.

INSPECTION

Sensitive edges should be checked daily as a safety precaution. Both edges of door should be checked to make sure that both edges operate. With doors in closed position, door bell should ring when pressure is applied to either door edge. Slight pressure against door edge, with doors closing should immediately reverse motion and open doors.

In the event a sensitive edge becomes inoperative, cause of trouble may sometimes be found in electrical cable which connects to micro-switch. Flexing of wire as doors are opened and closed may in time break electrical wire without affecting appearance of outer insulation.

Inspect all electrical connections periodically to make sure connections are clean and tight. Refer to applicable Wiring and Air Line Diagram.

ADJUSTMENT

When test indicates necessity for adjustment, sensitivity can be increased or decreased by tightening or loosening bottom cable nut. Nut is accessible from under lower end of sensitive edge (fig. 21). Cable should be so adjusted so that a 1-inch deflection near center of door will close switch contacts. With doors closed a 2-inch block, thrust between rubber door edges, should operate both switches.

DOOR CONTROL CAM SWITCH

Cam switch, used with sensitive edges, is mounted in door engine compartment above exit door, as typically shown in figure 22. Requiring no maintenance, switch consists of one double-throw and two or three single-throw micro-switches, and a nine-post junction block. Actuated by cams mounted on a common shaft, switches are operated by door engine linkage. Figure 22 shows positions of individual switches identified by letters A through D on Wiring and Air Line Diagrams at end of this group. Switches require no attention, except for correct adjustment of switch linkage, whenever any other door linkage adjustments have been changed.

LINKAGE ADJUSTMENT

Door engine linkage must be properly adjusted, as directed previously in this manual, before adjustment of switch linkage is attempted.

1. With exit doors closed, lengthen switch linkage until switch (B), shown on applicable Wiring and Air Line Diagrams, closes. This can be determined by means of a trouble light or voltmeter, or when "EXIT DOOR" tell-tale lights.
2. Shorten switch linkage until switch (B) opens. Tighten clevis lock nut.
3. Unload air from door engine by turning air valve, at left of driver, to "OFF" position.
4. Connect test light to Nos. 1 and 9 terminals on switch. Open doors slowly by hand, noting door position when test light indicates closing of switch. Doors shouod be approximately 3/4 open when switch closes.

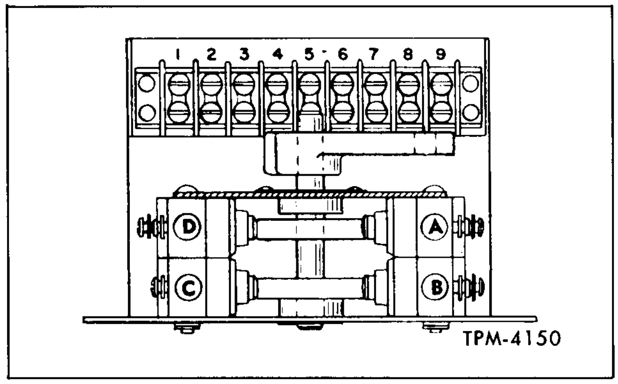


Figure 22—Door Control Cam Switch

DOOR SENSITIVE EDGE BELL

Door bell, used in connection with door sensitive edges, is mounted on dash panel at left of steering column.

Operation of bell (fig. 23) should be checked daily, as a safety measure, by applying pressure to sensitive edges.

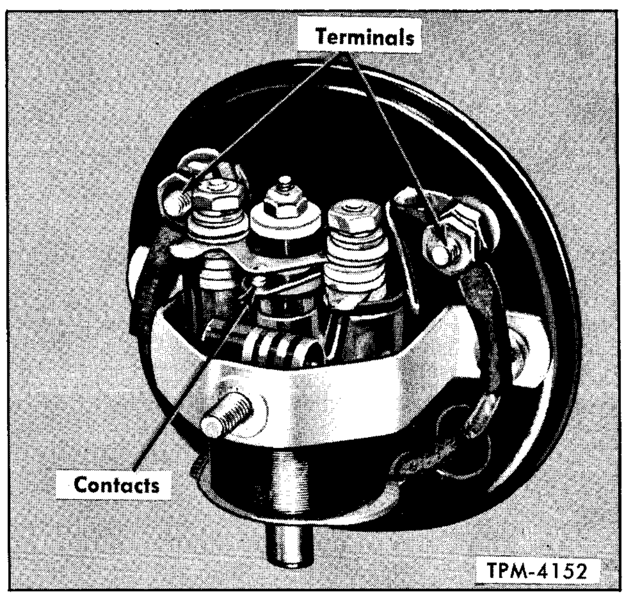


Figure 23—Door Sensitive Edge Bell

DOORS AND CONTROLS

Contacts of bell, should be inspected periodically, and cleaned if necessary. Contacts are accessible after removal of bell from base.

In the event of failure, check bell terminals and make sure current indication is obtained before replacing bell. Door bell electrical circuits are shown on applicable wiring and air line diagrams shown at rear of this section.

SPECIFICATIONS

Door Control Air Pressure Regulator Valve	
GM Part Number	2417152
Make	Midland
Model	M2-23
Stamped	N-15685-D
Pressure Setting	45 psi
Rear Door Lock Solenoid	
GM Part Number	1119921
Make	Delco-Remy
Stamped	1119921
Volts	12
Interlock Magnet Valve	
GM Part Number	2336345
Make	Midland
Stamped	N-2991
Type	Pressure
Interlock Air Pressure Regulator Valve	
GM Part Number	2336347
Make	Midland
Midland Number	N-13680-C
Pressure Setting	35-40 psi
Interlock Two-Way Check Valve	
GM Part Number	2336346
Make	Midland
Stamped	N-12488-C
Exit Door Bell	
GM Part Number	2318065
Make	Faraday
Faraday Number	K-336197

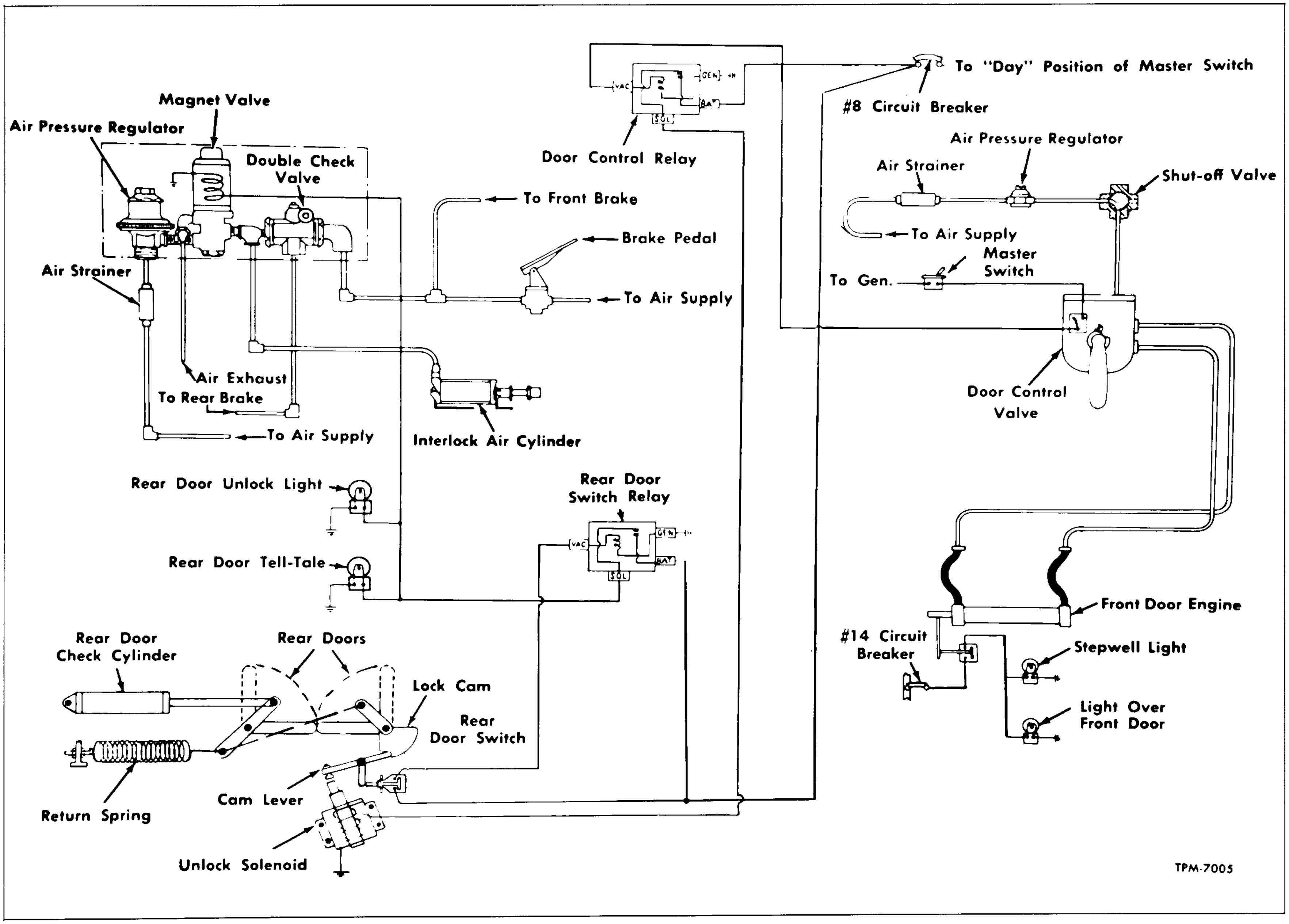


Figure 24—Schematic Arrangement of Door Controls, Air Lines, and Electrical Circuits—Push Type

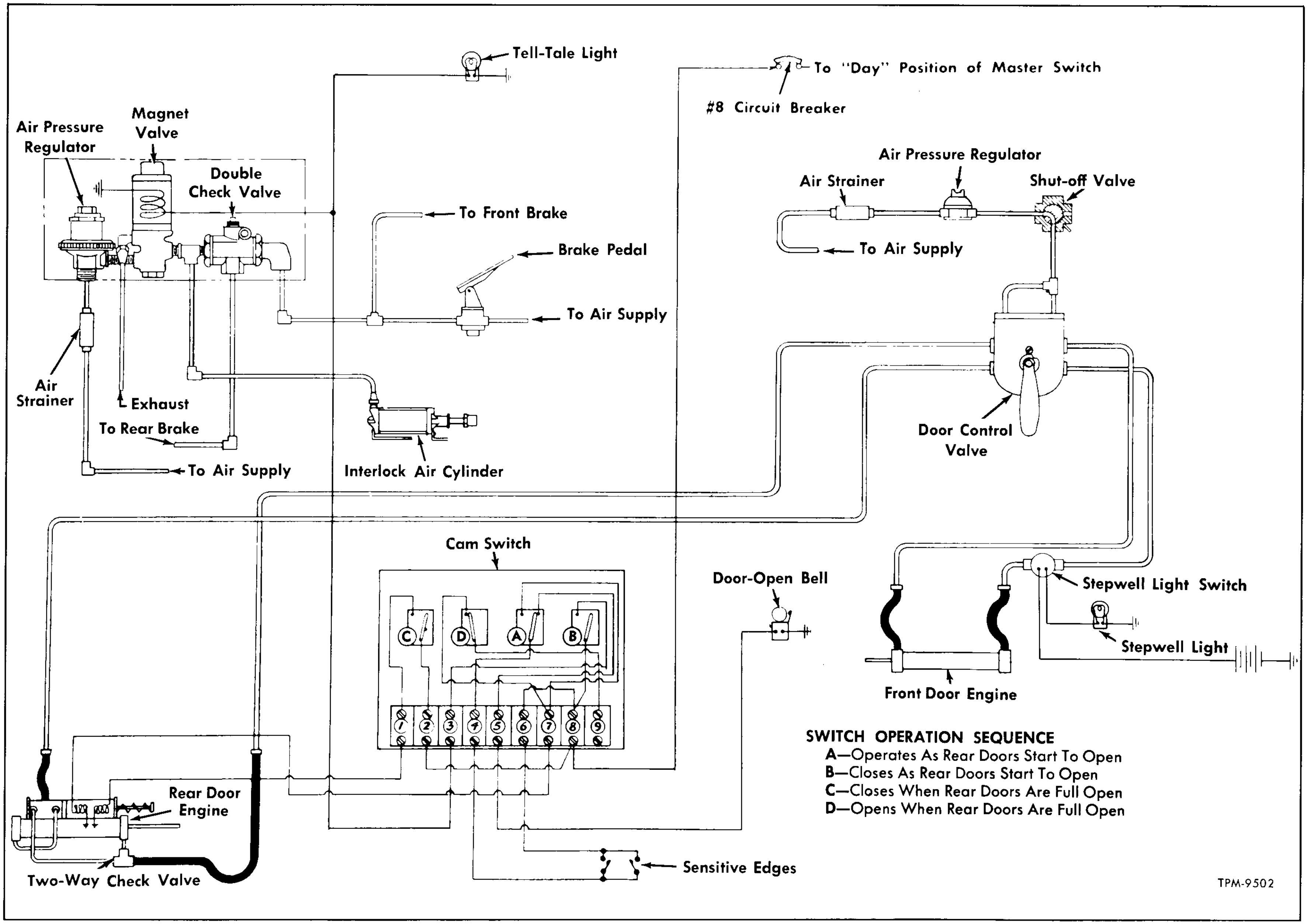


Figure 25—Schematic Arrangement of Door Controls, Air Lines, and Electrical Circuits—Front and Rear Air—Folding Type

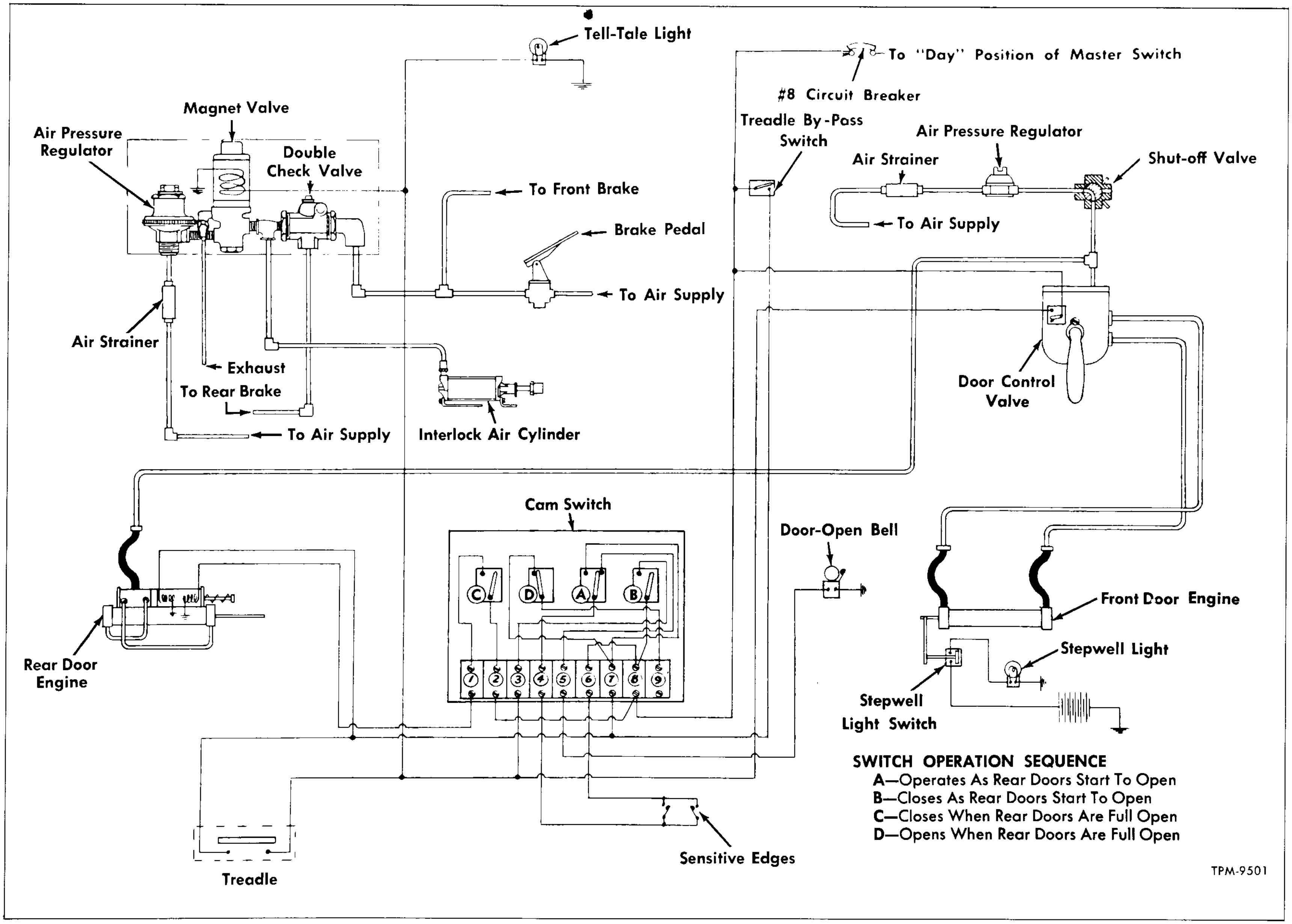


Figure 26—Schematic Arrangement of Door Controls, Air Lines, and Electrical Circuits—Front Air, Rear Air Electric—Folding Type

SCHEMATIC ARRANGEMENT OF MOST COMMONLY USED DOOR CONTROLS, AIR LINES, AND ELECTRICAL CIRCUITS ARE SHOWN IN THIS MANUAL.

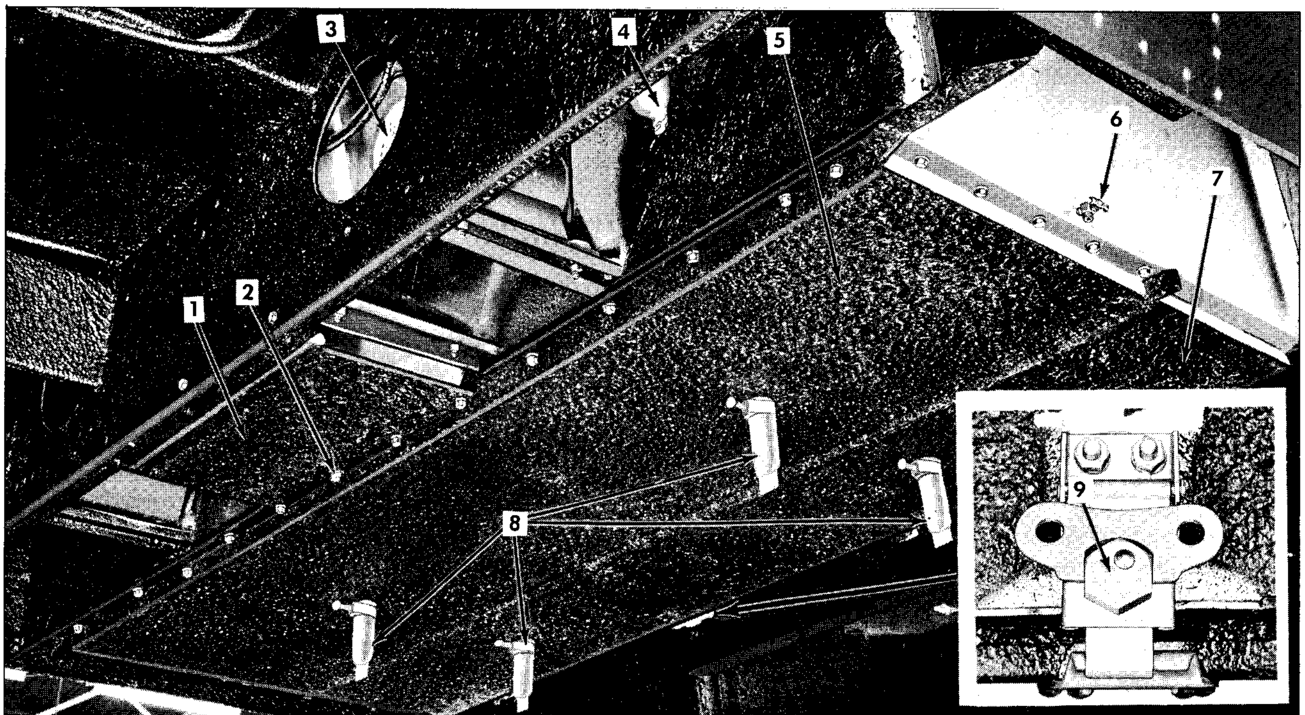
MANY COMBINATIONS AND TYPES OF SPECIAL EQUIPMENT ARE INSTALLED FOR DIFFERENT OPERATORS AND DIAGRAMS COVERING SUCH SPECIFIC EQUIPMENT CAN BE OBTAINED UPON REQUEST FROM THE FACTORY.

Heating and Ventilation

The underfloor heating compartment containing the heating core, air filters and blowers is shown in figure 1.

The heating system water lines and control units are shown schematically in figure 2. Heated, outside, and recirculated air flow, within the coach, are shown schematically in figure 3.

Wiring diagram covering the electrical phase of heating system is located at rear of this manual.



1 Access Door to Blower Relay and Circuit Breaker
2 Bolts
3 Blower Motor Assy.
4 Pressure Regulator Valve Assy.
5 Access Panel to Blower Wheels and Heater Cores
6 Heater Core Drain Cock
7 Access Door to Filter Screens
8 Moisture Drains
9 Access Door Latch Assy.
10 Air Filter Screens
11 Heater Core
12 Blower Wheel Venturi Ring
13 Blower Wheel
14 Set Screws
15 Motor Support Bracket
16 Motor Support Bracket Rail

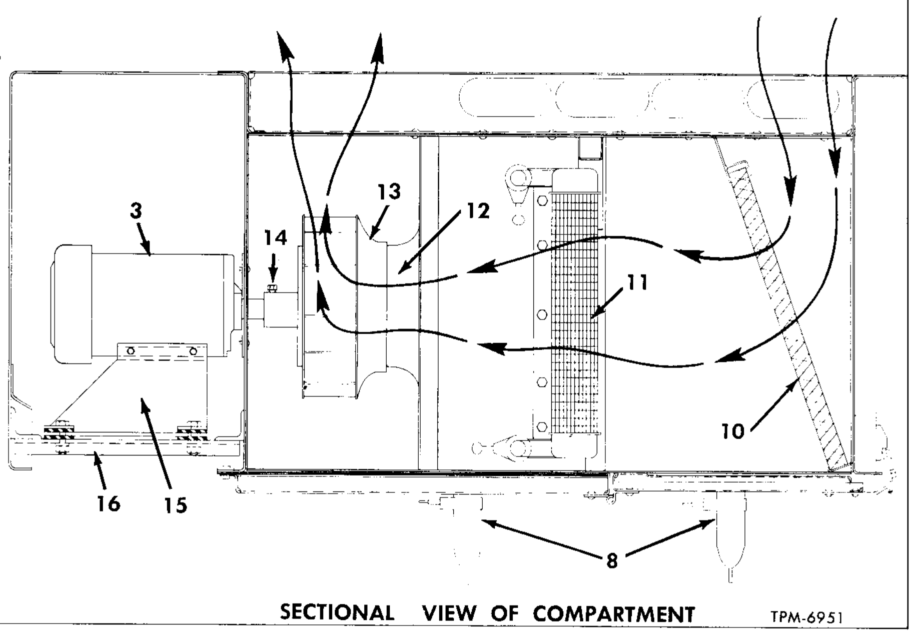


Figure 1—Underfloor Heating Compartment (Less Air Conditioning)

HEATING AND VENTILATION

DESCRIPTION

The heating system units and controls consist of the following:

1. The Grad-U-Stat, a thermostatically-operated air pressure control valve, which is mounted in recirculated air inlet on the floor under seats at right side of aisle on transit models and under the raised floor on suburban models.

2. The modulation valve, an air pressure operated water flow valve, which is installed in heater supply line on floor at rear of left rear wheelhouse on transit models and under the raised floor on suburban models.

3. The air pressure regulator valve, mounted underneath coach on bulkhead at right side of coach, controls the air pressure required for operating the Grad-U-Stat and modulation valve.

4. The underfloor heater core unit, consisting of two separate cores bolted together at ends, is located underfloor near center of coach.

5. Two electrically-driven motors and blowers located at rear of underfloor heater compartment.

6. The heating system water pump located in heater supply line on floor at rear of left rear wheelhouse on transit models and under the raised floor on suburban models. Water pump circulates water through the heating lines and cores.

7. Three screen type air filters located forward of the heater core unit in the underfloor heater compartment. Screens filter all the air passing through the compartment.

8. A dash heater unit, for the purpose of supplying heated air to driver, or to the windshield for defrosting, is located behind dash center closure panel.

NOTE: Most of the heating system units and controls are contained in or near the underfloor heating compartment as shown in figure 1. Access to filters is obtained by lowering hinged door (7, fig. 1) directly below filters.

To gain access to core unit and blower wheels it is necessary to remove closure panel (5, fig. 1) bolted directly below compartment.

SYSTEM OPERATION

As previously stated, the control of heating system is entirely automatic, and the system operates only while the coach engine is running.

Wiring diagrams at the rear of this manual should be referred to when following system operation.

On coaches without air conditioning, "BLOWER switch, located on a recessed switch panel at left of driver, when placed in "NORMAL" position will cause underfloor blowers to operate providing added ventilation less heat. When switch is placed in "OFF" position, motors will stop. However, if the Grad-U-Stat should, at any time, call for heat while switch is in the "OFF" position, blower motors will run regardless of "BLOWER" switch position. Current in this case is completed to the blower motors by the switch connected to, and operated by, the water modulating valve. When extra ventilation is not required, "BLOWER" switch should be returned to "OFF" position.

On coaches equipped with air conditioning, the underfloor blower motors are controlled by the "VENTILATION" switch on control panel at left of driver. Switch need not be rotated to "BLOWER" - "HI" or "LO" position for heating system to operate, as heater blower motors will run at low speed whenever the Grad-U-Stat calls for heat. However, on these coaches, the switch can be positioned to "HI" or "LO" as desired to provide added ventilation regardless of the demands of thermostat.

The water modulation valve switch is of the two-position type and the units which are actuated in either switch position are shown on "Heating and Ventilation Wiring Diagram" in back of this manual.

Defroster heater fan motor is controlled by a three-position switch marked "DEFROST" on control panel at left of operator. Motor will operate at either "HI" or "LO" speed.

AIR CIRCULATION

Air flow through heating system is shown in figure 3. A small portion of circulating air is outside air, admitted through grilled intakes below windows at each side of coach. This outside air replaces air exhausting from around door openings.

Both outside and recirculated air are drawn into underfloor heating compartment and distributed through longitudinal ducts along each side at base of wall and vertical wall ducts along seats.

Small outlets, located in longitudinal ducts at floor, allow heated air to flow under passenger seats. Outlet consists of a slider and a slider plate, as shown in figure 4.

Air to left side of driver's seat is admitted from duct at base of left wall by manually controlled damper which also acts as a deflector.

Air forced through defroster heater core may be recirculated air or outside air, as desired, by manual positioning of outside air inlet damper (fig. 5), at right side of heater core accessible after opening compartment door at right of dash. With damper closed (as shown), outside air will be admitted; with damper open, inside air will be recirculated.

NOTE: Excessive use of defroster heater will cause high temperature at front end of coach, thereby satisfying the Grad-U-Stat and leaving the balance of coach cold.

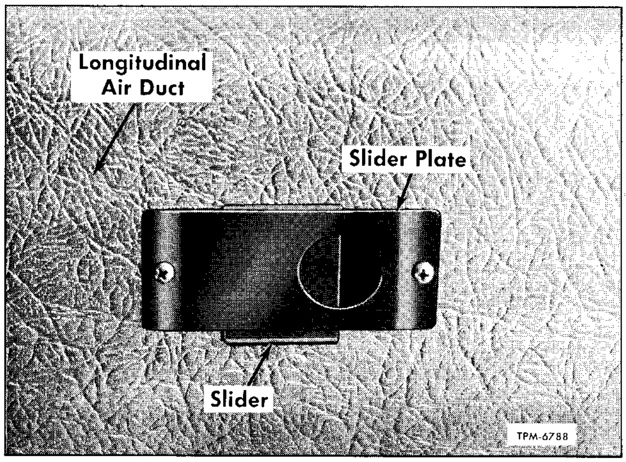


Figure 4—Air Duct Slider

WATER CIRCULATION (Fig. 2)

Hot water from the engine cooling system is forced to the heater supply line by the engine water pump. Electrically operated pump forces water through the coach heating system. Actual flow of water through the underfloor heater cores is controlled by the modulation valve (see figs. 6 and 7), which in turn, is controlled by the Grad-U-Stat thermostat.

Flow of water through the dash heater core is controlled by the manually adjusted control valve (fig. 8). Water modulation valve is air-operated, the air pressure delivered to it being graduated by the Grad-U-Stat, which is sensitive to inside coach temperature. After circulating through heater cores, water flows through the return line to the suction side of the engine water pump. Shut-off (gate) valve (fig. 9), located in return line provides manual means of closing or opening line circuit, to permit working on engine system without draining heating system (or vice versa). Valve is located underneath floor ahead of engine bulkhead at left side of coach.

Heating system water pump is energized to circulate water through the defroster heating system, when the following occurs:

1. When "DEFROST" switch on control panel at left of driver is placed in "HI" or "LO" position and engine is running.

2. When the water modulation valve is in open position, the Grad-U-Stat is calling for heat, and the engine is running.

MAINTENANCE

GENERAL

1. Heating system should be flushed semi-annually, following same general procedure as used for flushing main engine cooling system.

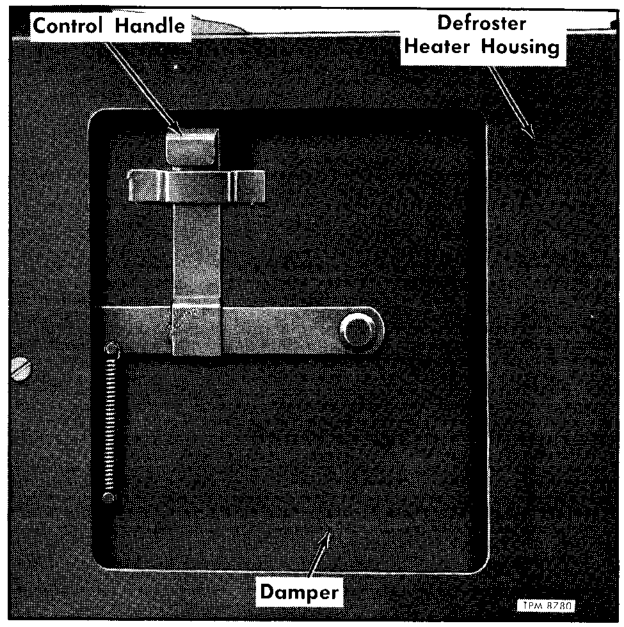
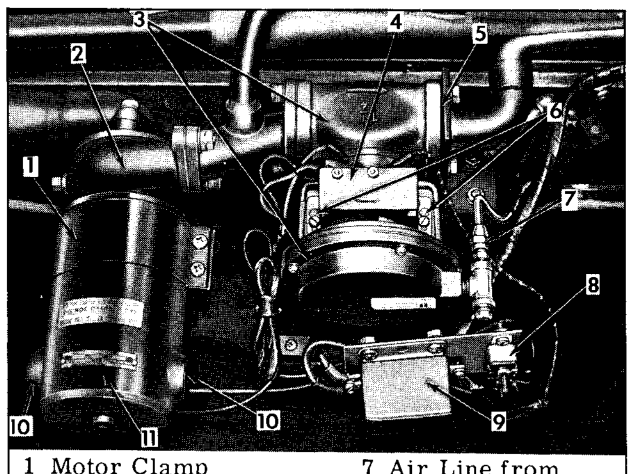


Figure 5—Outside Air Inlet Damper

2. At regular intervals, examine heater pipe joints and fittings, and heater cores for leakage and make the necessary repairs. Clean all dirt from heater cores.

3. Check for proper operation of heater blower motors, Grad-U-Stat, water modulation valve, and blower motor relays at regular intervals.

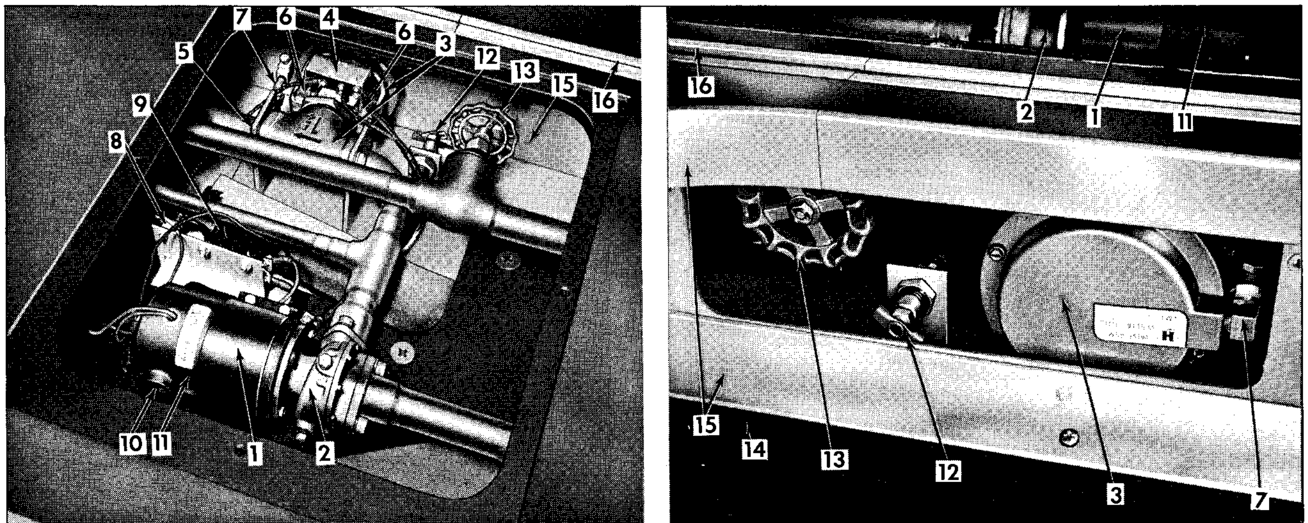


1 Motor Clamp	7 Air Line from Grad-U-Stat
2 Pump	8 Circuit Breaker
3 Water Modulation Valve Assembly	9 Pump Motor Relay
4 Pump Switch Assy.	10 Brush Cap
5 Gasket	11 Motor Assembly
6 Slotted Holes for Switch Adjustment	

TPM-9461

Figure 6—Modulation Valve and Heating System Water Pump Installed—Transit

HEATING AND VENTILATION



1 Motor Clamp	6 Slotted Holes for Switch Adjustment	11 Motor Assembly
2 Pump	7 Air Line From Grad-U-Stat	12 Drain Cock
3 Water Modulation Valve Assembly	8 Circuit Breaker	13 Shut-off (Gate) Valve
4 Pump Switch Assembly	9 Pump Motor Relay	14 Aisle Floor
5 Gasket	10 Brush Cap	15 Seat Riser
		16 Seat Track

TPM-9462

Figure 7—Modulation Valve and Heating System Water Pump Installed—Suburban

4. Drain plug is provided at bottom of pressure regulator valve, for draining moisture. Pressure regulator valve is located at rear of underfloor heating and cooling compartment on bulkhead at right side. Valve should be drained at regular intervals.

5. Possible causes of improper heating are explained later under "TROUBLE SHOOTING."

6. Clean underfloor heater filters at least once a week. Replace underfloor heater filters whenever they appear restricted.

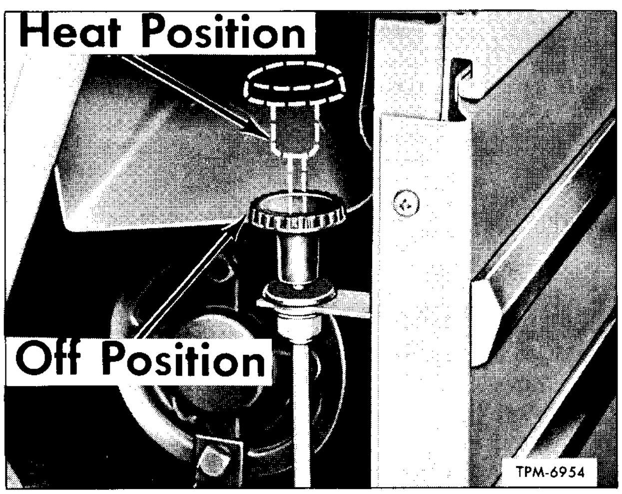


Figure 8—Driver's Heater and Defroster Water Valve Control

DRAINING

1. If heating system is to be drained without draining engine cooling system, close shut-off (gate) valve (fig. 9) located underneath floor ahead of engine bulkhead at left side of coach.

NOTE: Engine cooling system, likewise, can be drained separately from the heating system.

2. Make sure water modulation valve is open,

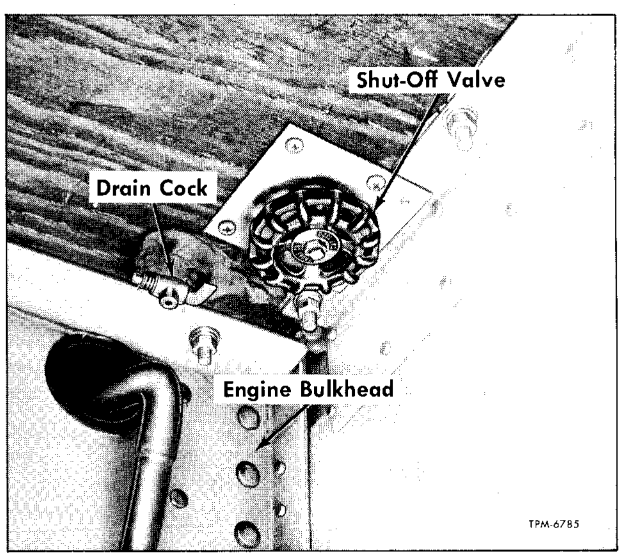


Figure 9—Shut-off Valve and Drain Cock At Engine Bulkhead

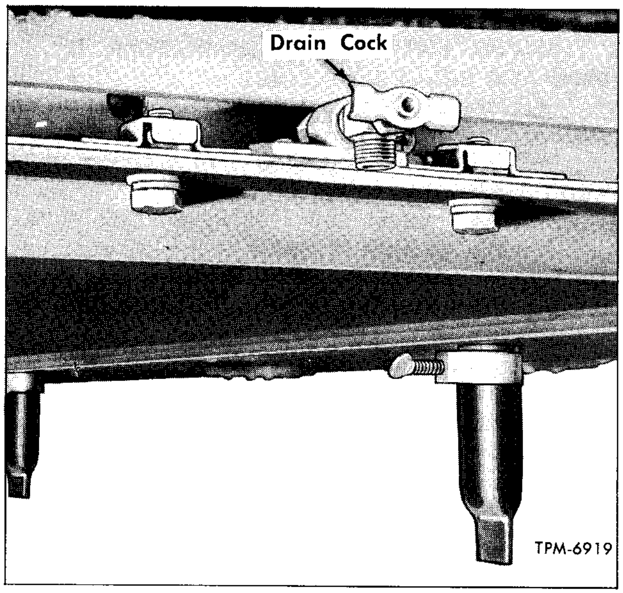


Figure 10—Underfloor Heater Core Drain Cock

by closing off air pressure supply at air pressure regulator valve, which is located on bulkhead at right of underfloor heater compartment.

3. Open drain cock (fig. 10) at lower right side of underfloor heater compartment to drain heater cores.

4. Open drain cock (fig. 9) near heater line shut-off valve, to drain supply line between engine and heating system pump.

5. Open drain cock (fig. 11) just above coach batteries, to drain defroster heater line midway between front and rear wheelhouses.

6. Open drain cock (fig. 12) underneath floor just to rear of left rear wheelhouse, to drain supply line connecting modulation valve and underfloor heater core.

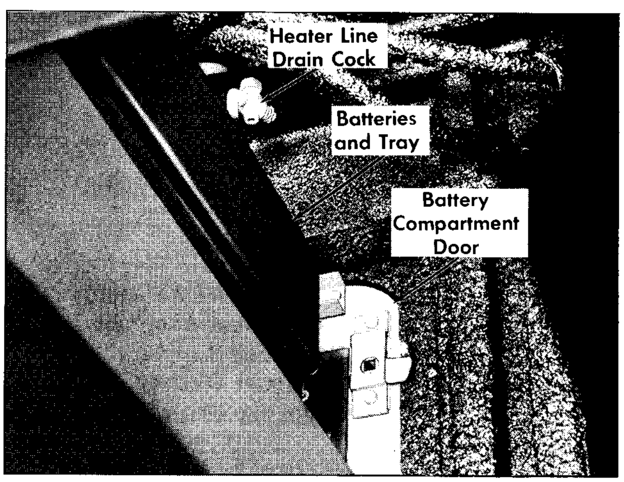


Figure 11—Heater Line Drain Cock Above Batteries

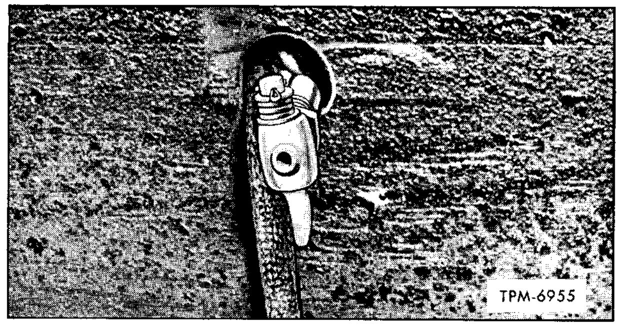


Figure 12—Heater Line Drain Cock At Rear of Left Wheelhouse

7. Open two drain cocks (fig. 13) in defroster heater lines. Drain cocks are accessible from underneath driver's compartment.

8. Open radiator surge tank to allow system to vent.

FILLING

1. Make certain all drain cocks mentioned previously under "Draining," are closed, that heater line shut-off valve (fig. 9) underfloor and defroster heater valve (fig. 8) are open.

2. Fill heating system in same conventional manner as for filling engine cooling system.

3. After initial filling, heating system water pump can be energized to assist in circulating water through heating system, by first running engine and then placing "DEFROST" switch on control panel at left of driver to "HI" or "LO" position.

4. Set air pressure regulator valve as explained later under "Air Pressure Regulator Valve."

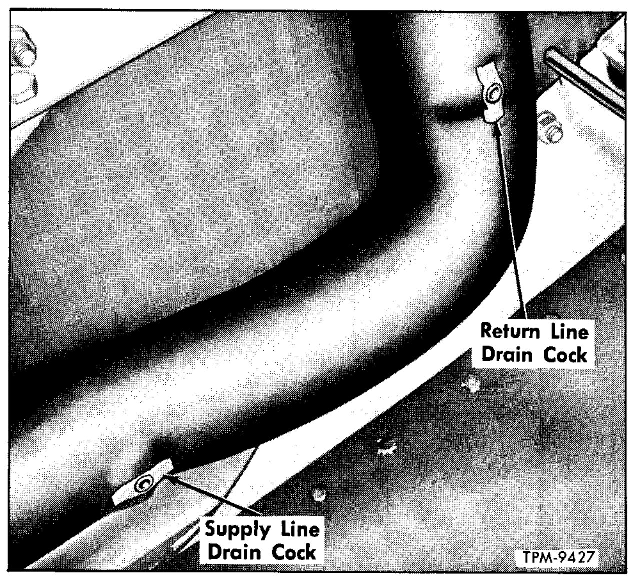


Figure 13—Defroster Heater Line Drain Cocks

BLEEDING

Whenever engine cooling or coach heating system has been drained and refilled, when systems have run low and water is replenished, or whenever sufficient air has accumulated in system to retard normal flow of water, heating system should be bled to expel air.

Before bleeding system, make sure all drain cocks are closed and that heater line shut-off valve is open, and that shut-off valve to defroster is open. Open vent screw at upper portion of defroster heater. Close vent when all air is expelled.

Operate heating system water pump for short period of time, as directed previously under "Filling," to bleed heating system.

HEATING SYSTEM WATER PUMP

Heating system water pump (integral with motor) is mounted under last, left-side seat with water modulating valve, at rear of left rear wheelhouse as shown in figures 6 and 7.

Pump operation is explained previously under "Water Circulation."

IMPORTANT: Never operate pump dry, as pump seal will be destroyed.

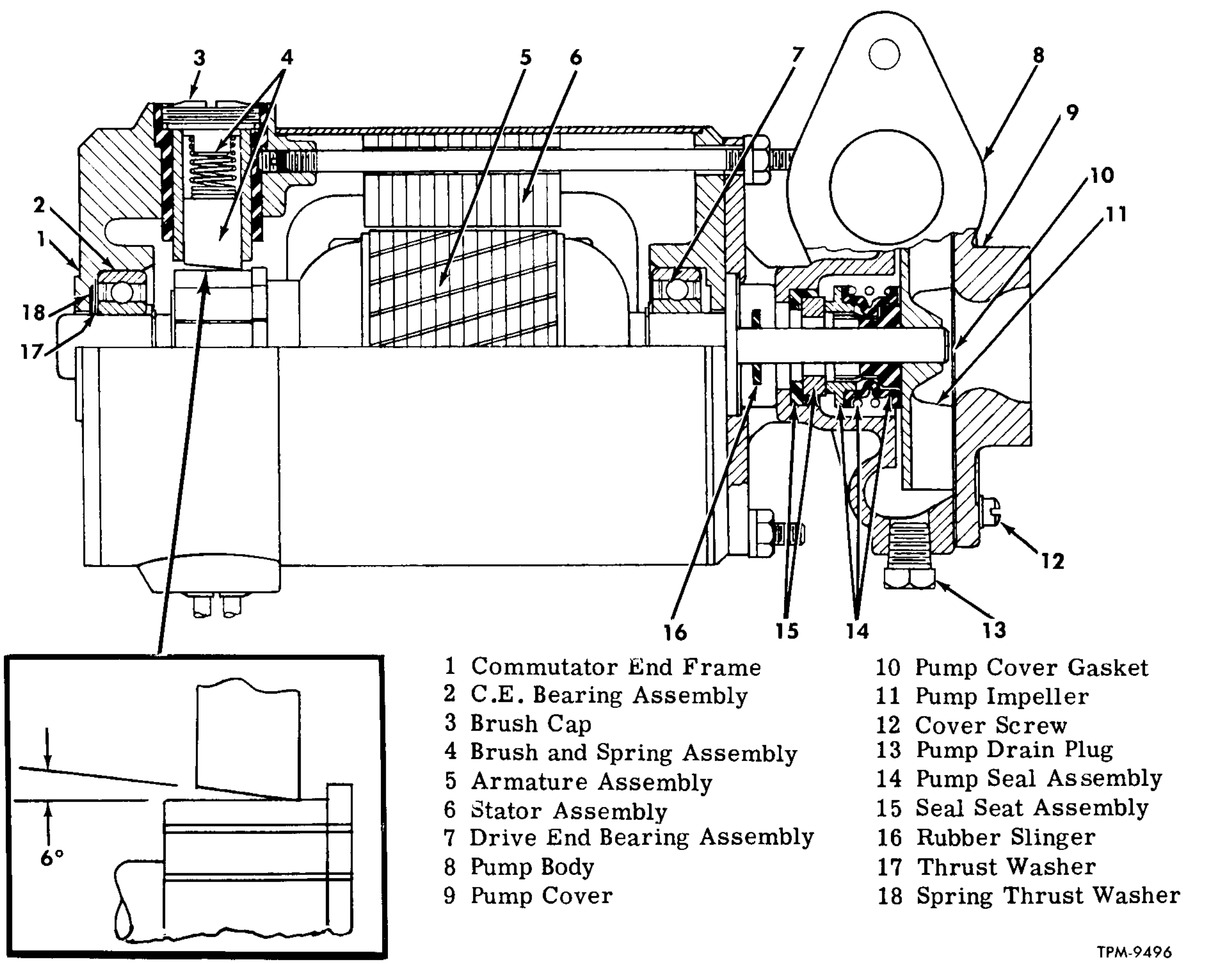
Wiring diagrams are located at rear of this manual.

Adjustment of control switch, mounted on the water modulation valve, is explained later under "Switch Adjustment at Water Modulation Valve."

Remove pump with motor as a unit, when necessary, for servicing. Motor brushes can be replaced without having to remove entire unit.

REMOVAL (Refer to Figs. 6 and 7)

1. Drain heating system to slightly below pump level as explained previously under "Draining."
2. Disconnect motor electrical wiring at relay and circuit breaker.
3. Disconnect water lines at flange connections, at pump inlet and pump outlet using 5/16" hex socket wrench.
4. Remove screws, nuts, and lock washers which attach pump motor clamp to motor mounting bracket. Remove pump with motor.



1 Commutator End Frame
2 C.E. Bearing Assembly
3 Brush Cap
4 Brush and Spring Assembly
5 Armature Assembly
6 Stator Assembly
7 Drive End Bearing Assembly
8 Pump Body
9 Pump Cover
10 Pump Cover Gasket
11 Pump Impeller
12 Cover Screw
13 Pump Drain Plug
14 Pump Seal Assembly
15 Seal Seat Assembly
16 Rubber Slinger
17 Thrust Washer
18 Spring Thrust Washer

Figure 14—Heating System Water Pump and Motor

DISASSEMBLY (Refer to Fig. 14)

1. Remove two brush caps (3) and two brush and spring assemblies (4).

2. Remove pump cover (9) by removing eight fillister head screws. Remove cover carefully to prevent damage to gasket (10).

3. Remove gasket (10).

4. Remove two hex nuts, and lock washers which attach pump assembly to motor.

5. Remove pump from motor in the following manner:

a. Install puller tool assembly (80-0202) to pump body (8) using four of the screws which were removed from the pump cover (9).

b. Tighten the puller screw which will press the motor shaft out of the impeller hub. The pump proper is now free of the motor.

6. Remove the puller tool.

7. Remove the impeller (11) and components of seal (14 and 15) assembly. (CAUTION: Do not damage the raised shoulder of the seal washer.)

8. Remove the floating seal seat (15) from the pump body by gently pressing from the motor side of the body.

CAUTION: Do not scratch or mar the sealing surface of this seat.

INSPECTION (Refer to Fig. 14)

Compare components with new parts to determine degree of wear.

Brushes

1. When removing brushes note the position of the brush in the tube. Brush life is markedly decreased if brushes are not replaced properly.

2. Brushes should be examined for:

a. Wear. Replace if less than 25% of the usable brush is left (less than .300 of an inch).

b. Chipped Edges. Chips can be caused by improper handling or installation. Badly chipped brushes should be replaced regardless of length.

c. Annealed Brush Spring. Can be detected by noting the resiliency of the spring. Annealing is caused by failing to tighten brush caps properly, thus not providing a good low resistance contact between the terminal and brush tube. Brushes evidencing annealed springs should be replaced.

d. Frayed or Broken Pigtail. An improperly installed brush may have the pigtail (shunt) pinched under the terminal or between the coils of the spring.

3. When replacing brushes the following items are important:

a. The face of a new brush is carefully cut to cause proper seating during the "wear-in" period.

b. Improper installation can harm both the brush and the commutator.

c. Replacement brushes should be of the proper grade.

d. New brushes have a 6° angle on the brush face. The brush should always be inserted so the angle is open away from the pump end of the assembly (see fig. 14).

e. Brush performance is degraded if the spring and terminal are not properly placed in the tube. The spring should be free over its entire length and the terminal should make good contact with the metal brush tube insert.

Bearings

1. Rotate motor shaft. If ball bearings show evidence of wear, they should be replaced.

2. When removing armature from motor, the number of washers and their arrangement should be noted. Improper number or installation of washers can cause improper tracking of brushes, excessive preloading of bearings and noisy operation.

3. The use of bearing pullers is recommended when removing bearings, to prevent damage to the armature winding or commutator.

4. Replacement bearings should be pressed to the same exact location as the original installation.

5. The use of a suitable sealant (such as Loctite or equivalent) is recommended between the shaft and bearing if the fit does not seem tight enough to prevent the shaft from spinning inside the inner race.

6. After replacing bearings, the position of the commutator in the motor can be checked by looking down the brush tube. Neither the riser nor the edge of the commutator should be visible.

Commutator

1. Commutators are precise assemblies. Although solidly built of fairly tough material they are easily ruined by careless handling.

2. Refinishing should be done only on equipment which will provide good concentricity and the proper finish.

3. Refinishing should be done if a micrometer reading shows a difference between "in track" and "off track" diameter of .187" or more.

4. The commutator should be carefully undercut with a .025" or less slot width.

5. A 25 to 50 microinch finish is desirable on a new or refinished commutator.

6. Commutator should not be touched with the fingers as sweat and body oils rapidly discolor and oxidize the surface.

Miscellaneous

1. Check the rubber shaft slinger (16) to make sure it is tight on the motor shaft. If it slips on the shaft it should be replaced.

2. Inspect the seal (14 and 15) assembly to determine wear. If the seal has leaked, or is badly worn, installation of a complete new assembly is recommended. However, in an emergency, or if a

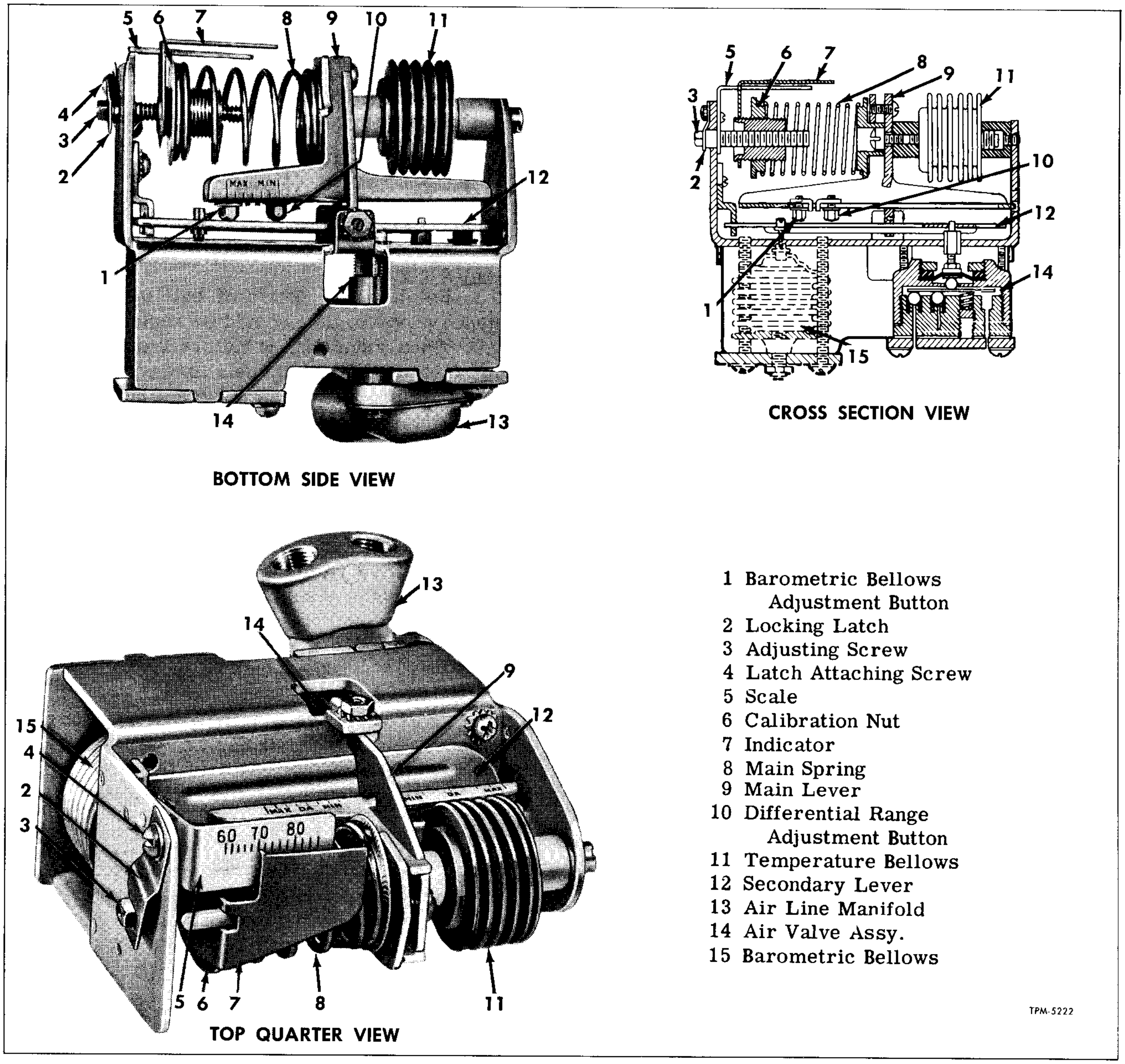


Figure 15—Heating System Grad-U-Stat Assembly

completely new seal assembly is not at once available, a new component may be installed to replace the damaged member. This procedure should be followed only when a complete new seal assembly is not available.

3. The impeller (11) is a press fit on the armature shaft. This press fit must be maintained to prevent the impeller from slipping. Install a new impeller if necessary.

ASSEMBLY (Refer to Fig. 14)

1. Install floating seal seat (15) in the pump body (8) in the following manner:

a. Clean seat in gasoline or some cleaning solvent to remove any dust or dirt.

b. Insert the seat in the proper recess in the pump body. This is a snug fit, but a drop of machine oil or a small amount of clean grease applied only to the neoprene ring and to the body cavity will insure easy installation. Be sure the seat bottoms in the pump body around its entire circumference.

2. Install slinger (16) on motor shaft.

3. Assemble body (8) to motor.

4. Lubricate pump shaft with a small amount of light oil then slip seal bellows and washer assembly (14) onto shaft so that the seal washer contacts the seal seat (15) in the pump body (8).

5. Install impeller (11) in the following manner:

a. Place impeller on flat surface with vanes against the flat surface.

b. Invert motor and pump body assembly and pilot pump shaft into impeller bore.

c. DO NOT HAMMER on the motor shaft extension at rear of motor. Press motor and pump body until the machined face of pump body is flush with the face of flat surface on which the impeller is resting. The face of impeller vanes must now be flush with machined face of the pump body.

6. Install gasket (10). This gasket is .010" thick and serves both to seal the cover and to establish proper clearance between the face of the impeller and the pump cover.

7. Attach cover (9) to pump body using eight fillister head screws (12).

8. Install motor brushes (4) and brush caps (3).

INSTALLATION OF PUMP AND MOTOR (Figs. 6 & 7)

1. Apply gasket cement to pump body line adapter and to line flanges. Position pump and motor assembly to mounting bracket and secure with clamp.

2. Reconnect lines to pump using new gaskets. Make sure connections are tight.

3. Connect electrical wiring.

4. Fill heating system as previously instructed under "Filling."

SWITCH ADJUSTMENT AT WATER MODULATION VALVE

Switch (4), which is mounted to water valve (3, figs. 6 and 7) must be located on valve to activate switch contacts, when water valve opens. When valve opens, switch tab engages valve stem to activate switch. Switch position is adjustable by means of two screw slots (6) at switch bracket (figs. 6 and 7). Loosen two screws which attach switch bracket and reposition switch as required. Tighten screws firmly after making adjustment.

NOTE: Closing and opening of switch contacts during adjustment can be checked by referring to circuits shown in "Heating Wiring Diagram" at rear of manual.

GRAD-U-STAT

DESCRIPTION

Grad-U-Stat (fig. 15), which is a thermostatically operated air control valve, is installed in recirculated air inlet located under seat, midway on right side of coach (fig. 16) on transit models and under the raised floor on suburban models. Two air lines connect to the unit. Main air line, connected to front port, is the main feed line from air pressure regulating valve, which limits the air pressure to 17 lbs; rear line carries air pressure

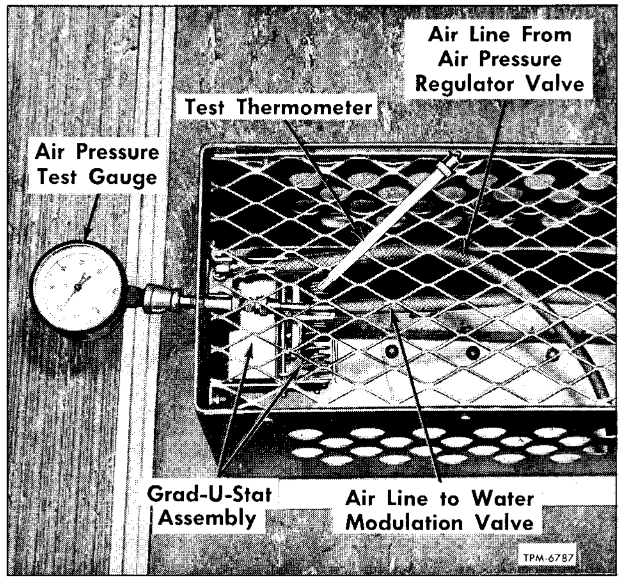


Figure 16—Grad-U-Stat With Test Thermometer and Air Pressure Gauge Installed

from the unit to the water modulation valve.

Vapor filled temperature bellows in unit is sensitive to inside coach temperature. Expansion and contraction of bellows, caused by increasing and decreasing coach temperatures, is transmitted to air control valves in lower portion of unit through levers.

An auxiliary bellows, unaffected by temperature changes, opposes the effect of altitude changes on the temperature sensing bellows.

OPERATION

NOTE: Key letters in text refer to figure 17, however, throughout explanation of Grad-U-Stat

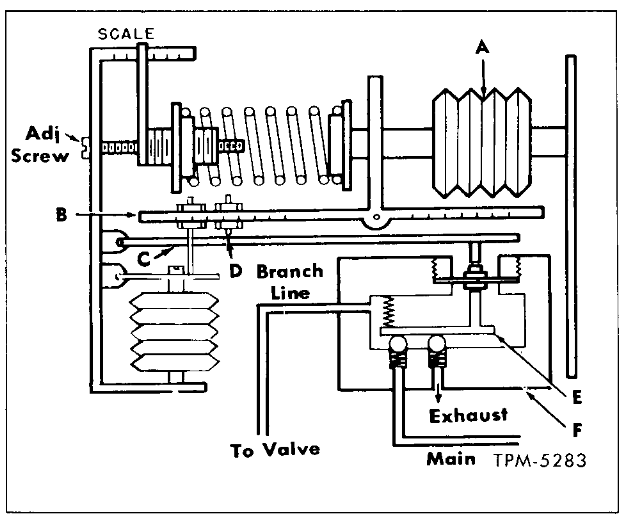


Figure 17—Grad-U-Stat Diagram

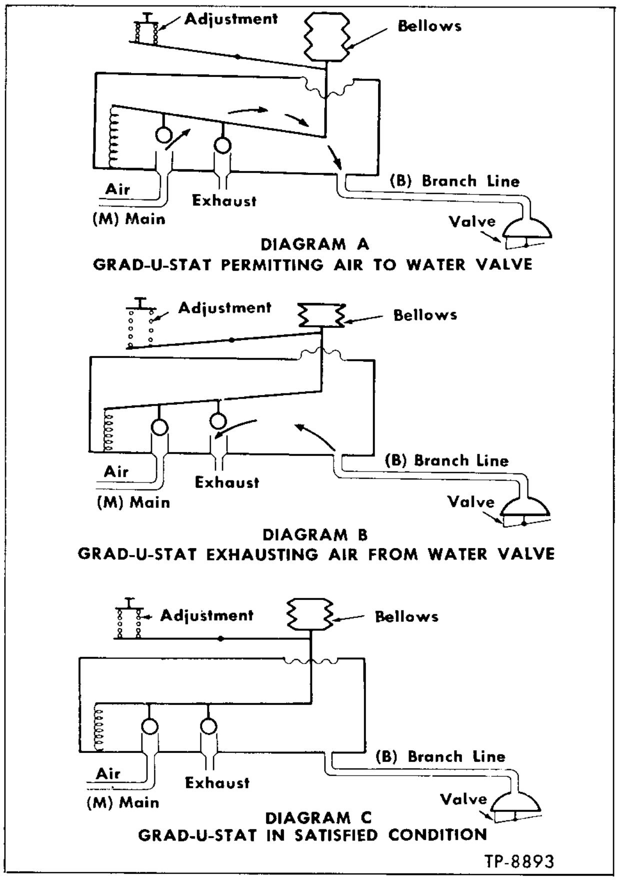


Figure 18—Grad-U-Stat Operational Diagram

Operation, reference is made to simplified diagrams shown in figure 18 which illustrate reaction of Grad-U-Stat under varied temperature conditions.

As temperature in coach rises, bellows (A) expands and exerts downward force on secondary lever (C) through main lever (B) and adjusting button (D). Downward movement of secondary lever is transmitted to lever (E) in air control chamber (F) of unit, increasing air pressure delivered to water modulation valve as shown in diagram A, figure 18. This increased air pressure at the modulation valve, causes the valve to close, reducing the flow of water through the underfloor heater core.

When temperature in coach lowers, the bellows (A) contract and relieves pressure exerted in air control valve lever (E). Air valve then exhausts air pressure from water modulation valve, increasing the flow of water through the underfloor heater core as shown in diagram B, figure 18. The air pressure delivered by the Grad-U-Stat varies in proportion to the inside coach temperature acting upon the bellows; thus, flow of water through underfloor heater core is graduated as required in accordance with inside coach temperature. Diagram "C" figure 18, shows status of Grad-U-Stat

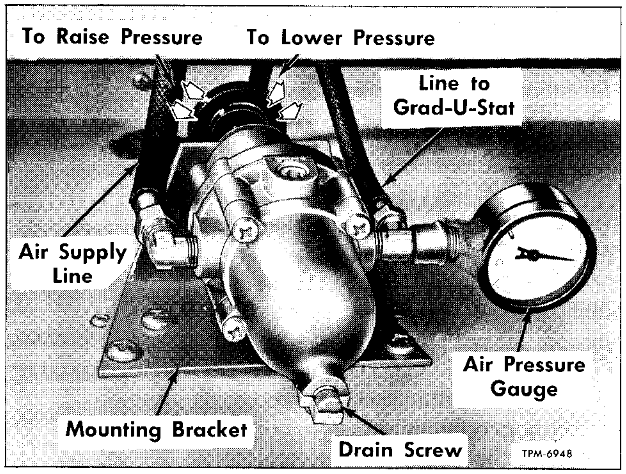


Figure 19—Air Pressure Regulator Valve Installed

when temperature in coach is approximately equal to temperature setting on Grad-U-Stat.

The differential range adjustment button (10, fig. 15) on the main lever, is set at the factory to provide a 6^{O}F. differential between fully closed and fully opened position. This setting has been found satisfactory for most operations and it is recommended that setting not be changed.

Grad-U-Stat is also altitude compensated, providing uniform temperature control when coach is operating at various elevations. An auxiliary bellows (15, fig. 15), unaffected by temperature changes, opposes the effect of altitude changes on the temperature-sensing bellows by retarding action of the secondary lever.

If air inlet screen, under seat, becomes clogged, flow of air over coils of Grad-U-Stat will effect efficiency of unit.

MAINTENANCE

1. Brush away all loose dirt or dust. If operation is restricted by corrosion or foreign material that cannot be brushed away, clean unit with a solvent, such as trichlorethylene. Recalibrate the Grad-U-Stat if the adjustments have been disturbed. See "Test and Adjustment" later.
2. Inspect the bellows. Dust will insulate the bellows and cause sluggish action.
3. Check the adjustment screw for binding; if it turns hard, clean, then coat it lightly with lubricant. Reset adjustment screw after lubricating.

TEST AND ADJUSTMENT

Key numbers in text refer to figure 15.

1. Shut off air supply to Grad-U-Stat at pressure regulator valve located underneath coach at right of blower motors (fig. 19). Turn adjusting knob completely counterclockwise to shut off air.
2. Remove plug from line elbow at Grad-U-Stat, then install air pressure test gauge (fig. 16).

3. Open air supply to unit by turning air pressure regulator valve adjusting knob clockwise, until pressure gauge at air pressure regulator valve indicates 17 lbs. pessure.

4. Check the air temperature at the bellows with an accurate thermometer (fig. 16).

IMPORTANT: Do not touch the bellows with hand while performing the following operation, as body heat will affect both units and erroneous readings and adjustments will be obtained.

5. Through opening in side of air inlet riser, on transit models (remove screen from seat riser in aisle on suburban models), loosen locking latch screw (4), disengage latch (2), from adjusting screw (3), then turn the adjusting screw to set the indicator at the temperature shown on the thermometer.

6. Observe pressure reading on air pressure test gauge. If reading is 8 pounds, no adjustment is required. If pressure is above 8 pounds, turn the calibration nut (6) and main spring (8) to shorten the spring until the correct reading (8 pounds) is obtained. NOTE: Compress spring when turning nut against increased spring compression. Release hand pressure on spring when checking readings. If pressure is below 8 pounds, turn calibration nut and main spring in opposite direction to lengthen the spring (spring compression not necessary).

7. After correct adjustment is obtained, turn adjusting screw (3) to set the indicator at desired operating temperature (75^{O}F. is factory setting), place locking latch (2) over adjusting screw, and tighten latch screw (4).

8. To check the differential range, find the temperature setting at which the pressure in line to water valve is 3 psi and the temperature setting at which line pressure is 13 psi. The number of degrees the setting must be changed to raise line pressure from 3 to 13 psi is the approximate differential range. If necessary change as follows:

a. Using a small open-end wrench, loosen the differential range button (10, fig. 15). Move the button to the desired position on its scale, and retighten range button. NOTE: To perform this operation, remove air inlet screen (on transit models).

b. Make sure differential range button is between the MAX. and MIN. markings on side of main lever (9, fig. 15). Maximum range is 10 degrees, minimum range is 3 degrees.

9. Remove test gauge and plug in air line tee.

10. Install screen in recirculated air inlet (on transit models).

11. Open air supply to Grad-U-Stat.

REMOVAL OF GRAD-U-STAT (Fig. 16)

1. Shut off air supply to Grad-U-Stat at regulator valve (fig. 19) by turning regulator screw completely counterclockwise.

2. Remove screen from over Grad-U-Stat on transit models or from seat riser in aisle on suburban models. Mark lines in relation to fittings, then disconnect air lines from unit.

3. Remove screws which attach unit to recirculated air inlet riser.

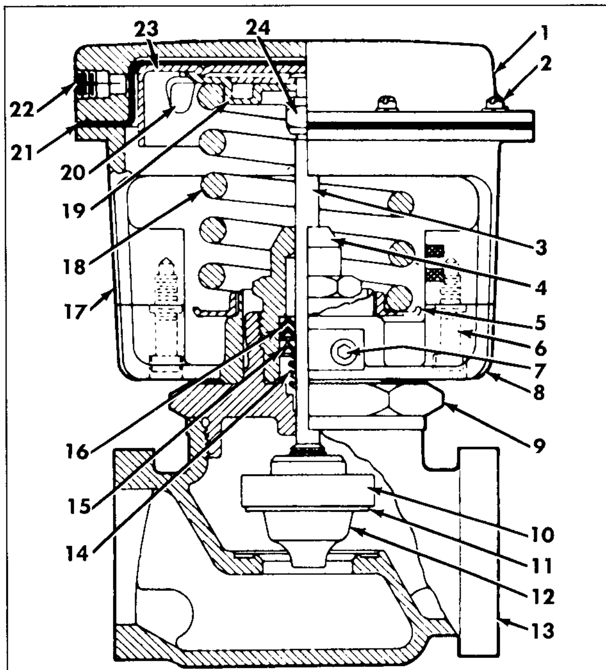
4. Remove screws which attach unit to mounting brackets.

INSTALLATION OF GRAD-U-STAT (Fig. 16)

1. Attach Grad-U-Stat to mounting bracket with screws; then install unit with mounting bracket to recirculated air inlet riser.

2. Connect lines to Grad-U-Stat elbows.

3. Test Grad-U-Stat operation, and adjust if necessary. Complete the installation as previously directed under "Test and Adjustment."



1 Cover	13 Valve Body
2 Cover Screw	14 Packing Spring
3 Valve Stem	15 Packing Washer
4 Packing Nut	16 Packing Ring
5 Spring Inner Seat	17 Outer Spider
6 Cap Screw	18 Return Spring
7 Set Screw	19 Spring Outer Seat
8 Inner Spider	20 Stem Retainer
9 Valve Bonnet	21 Diaphragm
10 Valve Disc Holder	22 Air Connection
11 Valve Disc	23 Diaphragm Cup
12 Valve Guide	24 Stem Button

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Figure 20—Water Modulation Valve

WATER MODULATION VALVE

Water modulation valve (fig. 20) is an air operated water control valve installed in heater water lines. Valve is accessible after removing access cover mounted on floor above valve (fig. 6) on transit models and after removing cover plate on floor under last seat (fig. 7) on suburban models.

Water modulation valve controls the flow of water through the heater core in accordance with the air pressure delivered to it by the Grad-U-Stat. Valve will start to close when subject to three pounds air pressure, and will be fully closed at 12 pounds pressure.

MAINTENANCE

1. Visually inspect for broken or kinked air line and broken or damaged parts.
2. Apply soapy water to air line connection (7, fig. 6) and to exposed edged of diaphragm. Unless coach is abnormally cold, leakage will be indicated by bubbles.
3. Use compressed air to blow dust and dirt from area around spring. Cleaning solvents such as trichlorethylene may also be used.
4. Check the valve packing for leakage.

NOTE: The packing nut (4, fig. 20) is self-adjusting; excessive tightening will not stop packing from leaking. The packing must however, be threaded completely into bonnet.

5. If leakage cannot be stopped, repack valve as explained later under "Repacking Valve."

REMOVAL OF MODULATION VALVE

1. Remove modulation valve access cover and air duct attached to floor and side with screws on transit models. Remove plate on floor beneath last seat on left side on suburban models.
2. Shut off air supply to valve by turning adjusting knob at pressure regulator valve completely counterclockwise; then disconnect air line from modulation valve.
3. Drain heating water system as previously directed under "Draining."
4. Disconnect electrical wiring to pump switch (4, fig. 6).
5. Remove four screws which attach valve to water line flanges. Remove valve assembly from between line flanges.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 20.

1. Unscrew valve bonnet (9) with valve mechanism from valve body (13).
2. Using a screwdriver through opening in outer spider (17), pry stem retainer (20) in or out to uncouple valve stem (3) from lock.
3. Place mark on cover (1) and outer spider (17) to assure assembly of parts in correct relationship; then remove cover screws (2) which attach cover to valve outer spider. Remove cover, diaphragm (21), diaphragm cup (23), stem retainer (20), outer spring seat (19), spring (18) and spring inner seat (5) from valve.
4. Remove two set-screws (7) which secure inner spider (8) to valve bonnet (9).
5. Outer spider (17) can be separated from inner spider (8) after removing two attaching cap screws (6).
6. Measure over-all length of stem assembly including stem button (20) and valve guide (12), to reassure adjustment to same length at time of assembly.
7. Using a nail in small hole of valve stem to hold stem from turning, thread stem button (24) from end of stem.
8. Unscrew packing nut (4) from valve bonnet (9); then slide packing nut, with packing ring (16), from stem (3). Remove packing washer (15) and packing spring (14). Remove packing ring (16) from packing nut (4).
9. Turn valve holder (10) valve disc (11) and valve guide (12) from end of stem (3).

ASSEMBLY

NOTE: Key numbers in text refer to figure 20.

1. Clean and inspect all parts before assembling valve. If any parts are damaged or worn; replace.
2. Assemble valve holder (10), valve disc (11) and valve guide (12) on end of valve stem (3) and tighten firmly.
3. Apply light silicone lubricant to packing rings (16) and to interior of packing nut (4), then insert stem through bonnet (9) and install packing spring (14), packing washer (15), one packing ring (16), another packing washer, remaining two packing rings (16), and packing nut (4) onto valve stem (3) in sequence mentioned. NOTE: Turn packing rings on valve stem threads with the spot of paint on each ring facing outward from valve body. Rings must be positioned as shown in figure 20. Screw packing nut (4) into bonnet (9) and then tighten nut firmly.
4. Thread stem button (24) on end of valve stem to a distance whereby over-all length of stem with stem button and valve guide equals measured length recorded prior to disassembly.
5. Attach outer spider (17) to inner spider (8) with two screws (6); then position spiders over bonnet (9) and secure with two set screws (7).
6. Position valve return spring inner seat (5), return spring (18), and spring outer seat (19) over valve stem in sequence mentioned; then compress spring and engage stem retainer (20) on end of stem (3).
7. Position diaphragm cup (23) over outer spring seat (19); then position diaphragm (21) over

cup. While holding valve in closed position (compress stem return spring), install cover (1) over diaphragm and spider. Align marks on cover and spider made prior to disassembly and attach with cover screws (2). Tighten screws firmly.

8. Screw bonnet (9) and valve mechanism into valve body (13); then tighten bonnet firmly.

INSTALLATION OF MODULATION VALVE
(Refer to Figs. 6 and 7)

1. Arrow on valve body indicates direction of water flow through valve. Valve must be installed with arrow on body pointing toward heater core.

2. Position valve assembly with a new gasket at each valve flange, between water line flanges. Install four cap screws through water line flanges and gaskets and thread into valve flanges. Tighten cap screws evenly and firmly.

3. Connect air supply line (7) to cover of valve. Open air supply to valve, by turning adjusting knob on pressure regulator valve, clockwise until pressure gauge at regulator valve indicates 17 lbs. pressure.

REPACKING VALVE

NOTE: Key numbers in text refer to figure 20.

1. Perform steps 1, 2, and 3 under "Removal of Modulation Valve."

2. Force the stem retainer (20) away from locked position with a screwdriver.

3. Loosen two spider set screws (7) then pull actuator unit (diaphragm, spring, and spiders) from valve bonnet (9).

4. Unthread stem button (24), exercising care not to disturb small set screw in end of stem button. Insert pin in small 1/16" hole just below stem button to hold stem while removing button.

IMPORTANT: DO NOT MAR STEM.

5. Thread packing nut (4) from bonnet (9). Remove spring (14) packing washers (15) and packing rings (16) from packing nut (4).

6. Clean and polish valve stem (3) if necessary with trichlorethylene and crocus cloth. Rub the stem lengthwise with cloth.

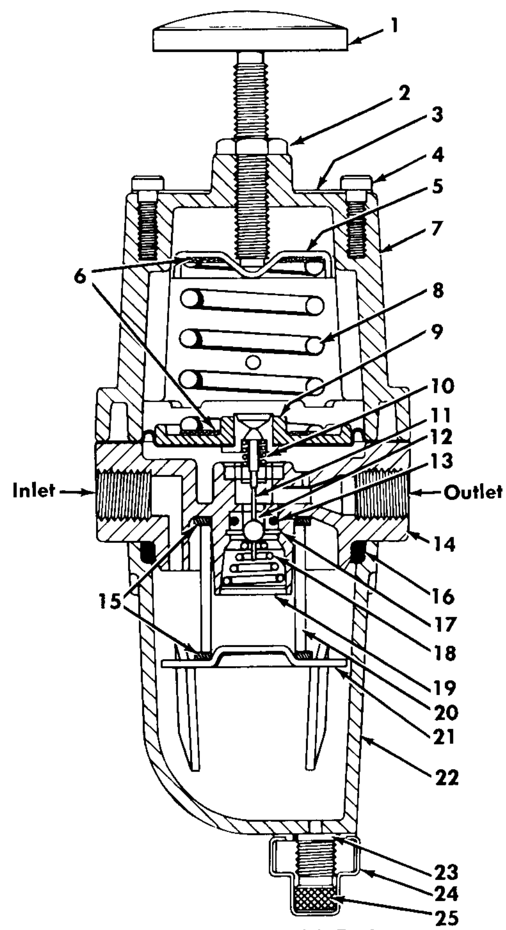
7. Dip the new packing rings in a light silicone lubricant and allow to drain. Also coat valve stem and inside of packing nut with lubricant.

8. In the following sequence, install packing spring (14) one steel packing washer (15), one packing ring (16), another packing washer (15) and remaining two packing rings (16) on valve stem (3).

NOTE: Turn packing rings over stem threads, with the spot of paint on each ring facing outward from valve body.

9. Replace the stem button (24) on valve stem (3). Tighten button firmly. Do not disturb set screw in stem button.

10. Reinstall the actuator units as directed previously under "Assembly" of valve.



1 Adjuster Knob	14 Body
2 Adjuster Lock Nut	15 Filter Gasket
3 Name Plate	16 Body Gasket
4 Panel Mounting Screw	17 Snap Ring
5 Spring Guide Plate	18 Valve Spring
6 Spring Cushion	19 Spring Snap Ring
7 Cap	20 Filter
8 Spring	21 Filter Retainer
9 Diaphragm	22 Bowl
10 Bleed Spring	23 Drain Valve Disc
11 Inner Valve	24 Drain Valve Retainer
12 Seat	
13 Seat Gasket	25 Drain Screw

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Figure 21—Air Pressure Regulator Valve Assembly

AIR PRESSURE REGULATOR VALVE

Air pressure regulator valve (fig. 21) is mounted on bulkhead at rear of underfloor heating and cooling compartment (fig. 19). Valve is accessible from underneath coach at right side. Valve serves two purposes, to strain the air of dirt and moisture and to regulate air pressure to Grad-U-Stat. As the Grad-U-Stat uses the compressed air,

the regulator valve admits additional compressed air, thus maintaining a constant pressure at Grad-U-Stat. Air pressure at Grad-U-Stat should be 17 lbs.

Should there be a constant bleeding of air through vent hole in the regulator cap (7, fig. 21), the inner valve assembly should be checked. Foreign matter may be lodged in valve seat or the valve may be worn.

ADJUSTMENT (Refer to Fig. 19)

When adjusting air pressure regulator valve, always observe air pressure reading on air pressure gauge at regular valve outlet. To adjust valve, loosen lock nut at top of valve unlocking valve adjusting knob. Turn adjusting knob counterclockwise to lower air pressure output. Adjusting knob in complete counterclockwise position will shut off air pressure entirely. To raise air pressure output, turn adjusting knob clockwise until desired air pressure output is indicated on air pressure gauge at valve. Air pressure gauge should be checked occasionally using test gauge to check accuracy of valve gauge.

DRAINING

Drain regulator valve at regular intervals to drain collected moisture by turning out drain screw (fig. 19) at bottom of valve. Tighten screw after draining.

DISASSEMBLY

NOTE: Key numbers in text refer to figure 21.

1. Loosen adjuster lock nut (2) which secures adjusting knob (1) in regulator cap (7). Turn out adjusting knob from cap.
2. Scratch or mark side of regulator cap (7), valve body assembly (14) and bowl (22) to assure original alignment at assembly. Remove four screws attaching these units together.
3. Remove regulator cap (7), spring guide plate (5), cushion (6), spring (8), another cushion (6), diaphragm assembly (9), and small bleed spring (10) from valve body (14).
4. Separate valve body (14) from bowl (22). Remove body gasket (16) from valve body, then remove filter (20), filter gaskets (15) and filter retainer (21) from filter body.
5. Inner valve (11) and valve spring (18) can be removed from valve body (14) after removing spring snap ring (19) from body.
6. Remove snap ring (17), then using a small hooked tool pull inner valve seat (12) with seat gasket (13) from valve body (14).

CLEANING AND INSPECTION

NOTE: Key numbers in text refer to figure 21.

1. Clean all parts except diaphragm (9) and valve body assembly (14) with cleaning solvent. Wipe diaphragm and valve body with clean cloth. Clean filter (20), using compressed air directed from inside of filter.
2. Make visual inspection of valve body (14) and bowl (22) for cracks and breakage. If diaphragm in valve body is cracked, it will be necessary to replace complete valve body and diaphragm assembly.
3. Replace springs indicating evidence of corrosion, fracture, or weakness.

ASSEMBLY

NOTE: Key numbers in text refer to figure 21.

1. Position drain valve disc (23) in bowl, then install drain screw (25). Install drain valve retainer (24) over drain screw to body.
2. Lower filter seat (21) with rubber gasket (15), filter (20), and another gasket (15) into bowl (22).
3. Place seat gasket (13) into groove of valve seat (12). Press seat with gasket into valve body and install retaining snap ring (17). Refer to illustration for position of parts.
4. Position body O-ring gasket (16) over shoulder of valve body (14).
5. Insert inner valve (11) and valve spring (18) in valve body and retain with spring snap ring (19). Refer to illustration for proper positioning of parts.
6. Lower valve body assembly over filter to bowl.
7. At top of valve body, position small bleed spring (10) over protruding needle point.
8. Position diaphragm (9) to valve body making sure center of diaphragm engages valve needle in valve body.

   NOTE: Top side of diaphragm has lipped-seat for engaging main spring (8).
9. Install main spring cushion (6) in spring seat of diaphragm, then install main spring (8), another cushion (6) and spring guide plate (5).
10. Lower regulator cap (7) down over spring to valve body. Align marks made prior to disassembly on bowl, valve body, and regulator cap. Make sure screw holes in diaphragm are also aligned. Install four screws attaching units together. Tighten screws firmly and evenly.
11. Thread lock nut on adjusting knob (1), then thread adjusting knob into regulator cap. Adjust regulator as directed previously under "Adjustment."

UNDERFLOOR HEATING AND COOLING COMPARTMENT

Underfloor heating and cooling compartment is located under coach floor near center of coach as shown in figure 1. Compartment includes air filters, (air conditioning evaporator coil - when used), heater core, and blower wheels.

Access to compartment is gained either by opening access door to filters and evaporator (when used), or by removing the entire closure panel, bolted to bottom of compartment for access to heater core, and blower wheels. Figure 1 shows underfloor compartment.

The heating compartment is sealed to outside air below coach by seals around blower motor shafts and around access door and closure panel.

Rubber water drains in closure panel and hinged access cover allow moisture collected in compartment to drain, and are so designed to prevent outside air from entering compartment from below coach. If drains fail to function as designed, they should be replaced. To replace drains remove clamps, then pull from panel flange. Install new drains by stretching round end of drain over panel flange. Secure drains with a clamp.

UNDERFLOOR HEATER CORE UNIT

The heater core unit located in the heating and cooling compartment, between the evaporator and blower wheels is of fin and tube design, similar to a conventional radiator. The core assembly actually consists of two separate core units flanged-connected with bolts.

Core units can be repaired in same manner as a conventional radiator.

REMOVAL

NOTE: Individual heater core units can be replaced separately or as a complete unit.

1. Remove closure panel from below heating and cooling compartment by removing the attaching cap screws.
2. Drain heater cores by opening drain cock at right of compartment (fig. 10). After draining, remove necessary connecting pipes and hoses.
3. While supporting core units safely, remove cap screws which attach flanged ends of core units to bulkhead and the core center support bracket. Carefully lower core unit from compartment.

INSTALLATION

1. If heater cores are to be installed as a complete unit, attach cores together and install connecting pipes and hoses. Make sure hose clamp screw heads are positioned to provide access from below coach when unit is installed.
2. Raise core unit into position and secure flanged ends of core to bulkhead and core center support bracket with cap screws and lock washers.
3. Connect heater supply and return pipes to core unit. Tighten hose clamps firmly.
4. Fill heating system as explained previously under "Maintenance." NOTE: Checking for possible leaks at core connections should be made when water in core is warm.
5. Tighten all hose connection clamps firmly, then install closure panel to underside of heating and cooling compartment.

NOTE: Make sure closure panel gasket is in good condition to provide complete seal between panel and coach understructure.

UNDERFLOOR BLOWERS AND MOTORS

Two blower and motor units are used to circulate air through the heating system. Both units are mounted on bulkhead at rear of the heating compartment (fig. 22).

Blower motors are accessible from underneath coach only. Motors can be overhauled, and electrical circuits tested following standard automotive practices.

On vehicles equipped with air conditioning, blower motors are of two-speed type. The blower motor high speed circuit is controlled by a magnetic switch (relay) which is mounted on bulkhead between blower motors. See figure 6 in ELECTRICAL (SEC. 7). Magnetic switch is energized to complete blower circuit when "VENTILATION" switch, on panel at left of driver is placed in "BLOWER," "HI" or "AIR CONDITION" position. The high speed circuit to each motor is protected by a 90 amp. circuit breaker located on bulkhead next to magnetic switch. Low speed circuit in these coaches is energized by the switch at water modulation valve (when Grad-U-Stat calls for heat) or by the "VENTILATION" switch on panel at left of driver when switch is placed in "BLOWER," "LOW" position. Refer to "Air Conditioning Wiring Diagram" at the rear of this manual.

On vehicles without air conditioning the blower motors operate at one speed only. Circuits to blower motors are completed by blower control

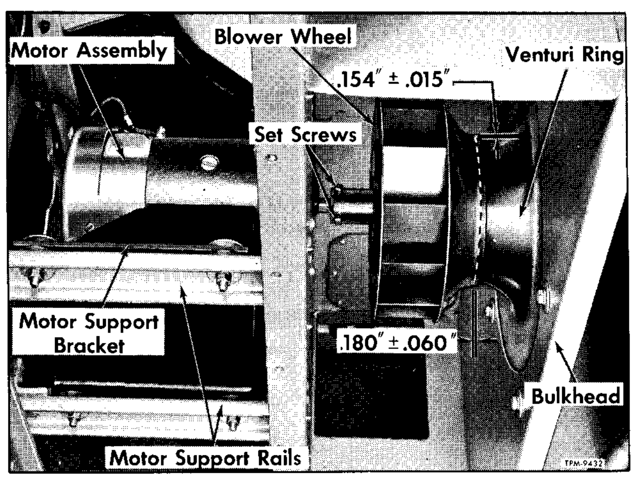


Figure 22—Blower Motor and Wheel Installed

relays mounted on bulkhead between the blower motors, as shown in figure 6 in ELECTRICAL (SEC. 7). When relay operating coils are energized, by either the "BLOWER" switch on panel at left of driver or the water modulation valve switch, the relay coil operating (primary) circuit and the battery (secondary) circuit are completed to the blower motors. One field coil winding in motor energized through the relay operating coil (primary circuit) is grounded through the motor. This same winding incorporates a thermostatic unit. In the event motor should draw excessive current through this circuit the thermostatic unit will open the blower relay operating coil (primary) circuit which in turn breaks the secondary circuit to blower motor.

Refer to "Heating Wiring Diagram" at the rear of this manual.

REMOVAL OF BLOWER WHEELS AND MOTORS

1. Remove large closure panel from below the heating and cooling compartment to gain access to blower wheels.

2. Referring to figure 22, mark position of blower wheel to venturi ring, then loosen two set screws which secure blower wheel to motor shaft.

3. Disconnect wiring from terminals on motor.

4. Remove four bolts attaching motor to motor support bracket. While making sure blower wheel will not drop from motor shaft, carefully move motor unit rearward to pull motor shaft from blower wheel. Remove motor. CAUTION: Do not allow blower wheel to fall from end of shaft.

5. If necessary, motor support bracket and support rails can be removed from underframing.

INSTALLATION OF BLOWER WHEELS AND MOTORS

1. Referring to figure 1 for arrangement of rubber cushion mounts, install motor support rail and motor support bracket in heating compartment. Each mounting consists of 1 shoulder bolt, 1 large flat washer, two rubber cushions, bolt nut and lock washer. Tighten nuts firmly.

2. Place blower motor into motor compartment through hole provided in bulkhead and insert motor shaft through rubber bulkhead seal to engage blower wheel. Attach motor to support bracket with four 5/16-18 x 5/8" bolts and lock washers.

IMPORTANT: Longer bolts may damage motor.

3. Slide blower wheel fore or aft on motor shaft to a position whereby wheel will overlap edge of venturi ring by 0.180" $\pm$ 0.060" as shown in figure 22. After obtaining this adjustment, tighten wheel set screws firmly. See figure 17 in AIR CONDITIONING (SEC. 26) for overlap dimensions with air conditioning.

4. Blower wheel should be concentric over edge of venturi ring at a dimension of 0.154" $\pm$ 0.015". This adjustment can be made after loosening the cap screws which attach the venturi ring to coach bulkhead, then repositioning ring on bulkhead to obtain specified clearance. NOTE: Holes in ring are large, to permit adjustment.

5. Connect wiring to motor terminals, then check operation of blowers. CAUTION: Do not attempt to operate blowers from below coach using a hot lead; refer to "IMPORTANT" under "Relay 2351703" in "WIRING AND MISC. ELECTRICAL" (SEC. 7) of this manual.

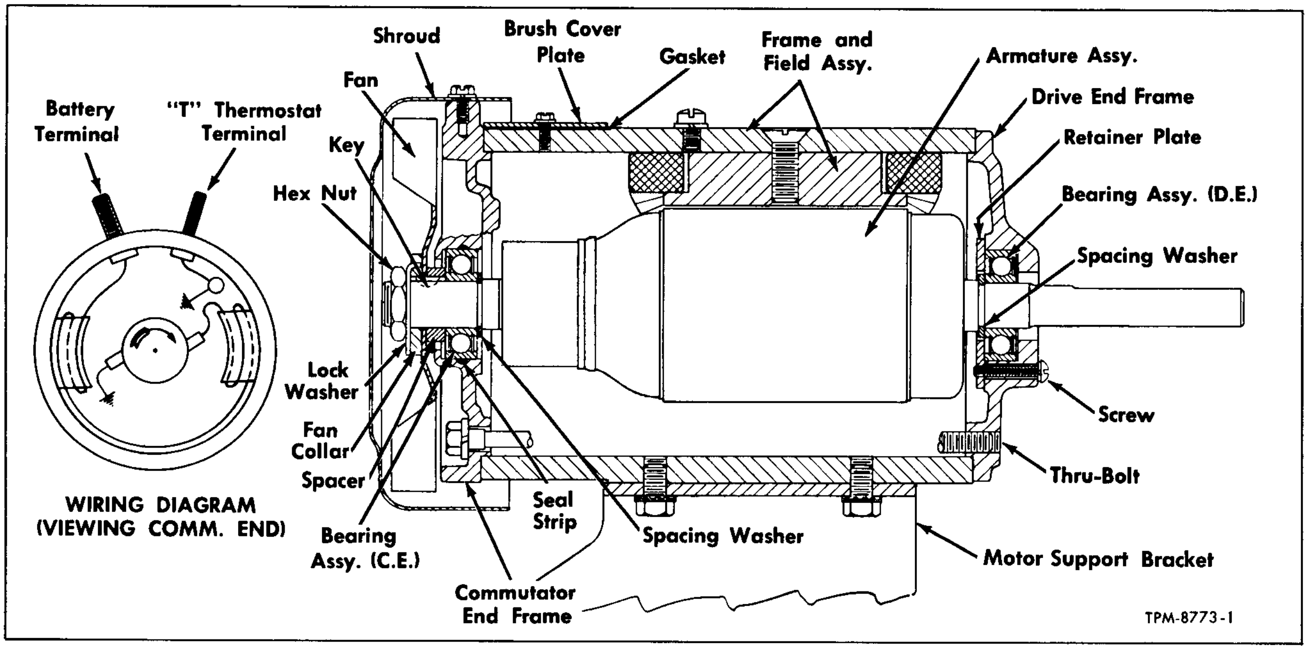


Figure 23—Underfloor Blower Motor

NOTE: Operation will be noisy if blower wheel contacts venturi ring. Operate motors for this test only long enough to check clearance, as motor current draw with closure panel removed will be high.

BLOWER MOTOR REPAIR

COMMUTATOR AND BRUSHES

Motor commutator can be cleaned and brushes replaced without disassembling motor.

Motor may be serviced in coach by removing four bolts holding motor to bracket and three screws holding shroud. Motor may then be rotated freely to service brushes.

1. If commutator is dirty, clean with strip of No. 00 sandpaper. Do Not Use Emery Cloth. All dirt must be blown from motor after cleaning.
2. Brushes should be replaced if they measure less than 3/4 inch on the long side. If brushes are of sufficient length but are not seating on commutator properly, seat brushes, using a "bedding" stone. Do Not Use Emery Cloth or Sandpaper. With motor operating, press bedding stone firmly against area on commutator contacted by brushes. Brushes should seat satisfactorily in a short period. Blow motor out with compressed air to remove all particles of abrasive after using stone, then check tightness of pigtail lead connections.
3. To replace brushes, refer to figure 24, which shows operational brush replacement views.

a. To remove individual brush, push down on spring and back assembly, then forward toward brush to disengage back from retaining lugs. See left view of figure 24. Release back, and remove from motor. Do not attempt to remove brushes prior to removal of spring and back assembly as the spring may be damaged and improper brush tension will result.

b. Center view of figure 24 shows brush separated from spring and back. Remove screw which secures brush cable to bracket. Remove brush.

c. Install new brush in brush holder, insert back and spring assembly inward beyond installed position, then away from brush to engage internal retaining lugs as shown in right view of figure 24.

d. Attach brush cable to bracket with screw.

DISASSEMBLY OF MOTOR

NOTE: Figure 23 shows sectional view of motor assembly.

1. Remove fan shroud, then nut which retains fan to motor shaft. Remove fan, fan spacer, and key.
2. Remove thru-bolts which attach endframes to motor housing.
3. Remove cover, springs and brushes.
4. Tap end frames with soft hammer to loosen, then separate end frames.
5. Remove armature from motor housing and winding assembly.
6. If necessary, shaft bearings can be readily removed from shaft or end frames using a conventional bearing puller.

PARTS INSPECTION AND TEST

Before proceeding with repair operations, the following inspections should be made:

1. Check armature to commutator leads to be sure they are properly soldered. Loose leads

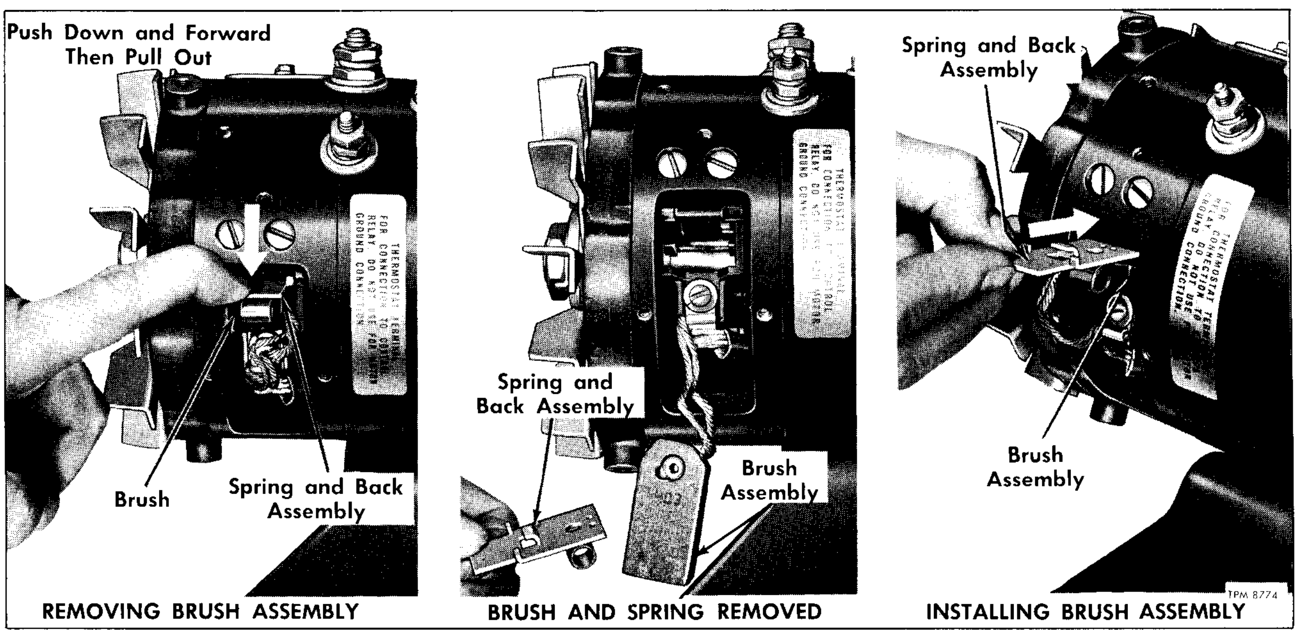


Figure 24—Replacing Underfloor Blower Motor Brushes

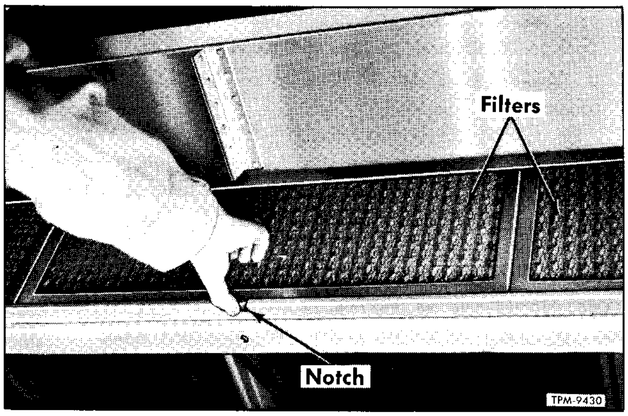


Figure 25—Removing Air Filters

should be resoldered.

2. Inspect commutator and if found to be rough, out-of-round, worn, has high mica, or is badly burned, replace armature or repair commutator as instructed later under "Armature Repair."

3. Inspect field coil insulation. If insulation is cracked, charred, or worn so that wire is exposed, it is recommended that field coil and frame assembly be replaced.

4. Check length of brushes and replace if less than 3/4 inches long, measured on longest side. Be sure that pigtail leads are secure in the brushes and that terminals are properly fastened to leads.

5. Carefully inspect ball bearing assemblies for evidence of damage or wear. If rough, pitted, or worn; replace bearing assembly.

6. Inspect brush bracket assembly and brush retainer spring assembly for wear or damage. If either assembly is badly worn or broken, replace.

TESTING ARMATURE

1. With a conventional test light and prods, test armature for ground. Place one test prod on armature and other on commutator. If test light lights, armature is grounded and should be replaced.

2. If armature is open circuited, this can easily be detected visually, since an open circuit in the armature usually results in badly burned commutator bars.

3. To test armature for short circuit, place armature on growler connected to alternating current. Hold hack saw blade over armature while armature is rotated slowly. If saw blade vibrates or buzzes, armature is short circuited and should be replaced. However, before replacing an armature that is apparently shorted, inspect commutator slots for copper or brush dust deposits, clean thoroughly, and re-test.

4. Test armature terminal circuits for continuity. Place one test prod on armature terminal and other on terminal of each wire. If test lamp fails to light, wire is open circuited and should be replaced.

ARMATURE REPAIR

1. To turn down commutator, center armature in lathe; then machine until rough or worn spots or out-of-round condition has been removed.

CAUTION: Machine only necessary amount.

2. Mica between commutator segments must be below surface of segments. If this condition does not exist, undercut mica until it is 1/32" below surface of segments. After undercutting, use No. 00 sandpaper to clean and smooth up commutator, then use compressed air to remove all fine particles of cuttings.

3. If armature is open-circuited, burned commutator riser bars may result. When bars are not too badly burned, armature can sometimes be saved by rewelding the leads in the riser bars. After welding, turn down commutator and undercut mica as directed in steps 1 and 2.

ASSEMBLY OF MOTOR

After all parts have been inspected and repaired or replaced, blower motor may be assembled as follows:

1. Insert new seal strip into groove within commutator end frame bearing recess. Coat strip with a clean lubricant, then install new bearing assembly in end frame.

2. Install bearing in drive end frame. Bearing assembly is retained in end frame by a plate which is secured with screws.

3. With small washer located on shaft at each end of armature winding, position armature, case, and end frames, then install retaining thru-bolts.

4. Connect all leads and install brushes.

5. At commutator end of motor, install ventilating fan to motor shaft. Referring to figure 23, install spacer, drive key, fan, fan collar lock washer and hex nut. Tighten nut firmly.

BLOWER MOTOR CONTROL RELAYS AND CIRCUIT BREAKERS

Blower motor relays and circuit breakers are mounted on bulkhead at rear of heating and cooling compartment between blower motors as shown in figure 6 in ELECTRICAL (SEC. 7). Relays and circuit breakers are accessible after removing four bolts attaching access door to bulkhead, then lowering hinged door.

AIR FILTERS

Three air filters, mounted to front of heating compartment (fig. 1) filter all air passing through the compartment. Filters are accessible from underneath coach after opening access door directly below compartment. Door is retained in closed

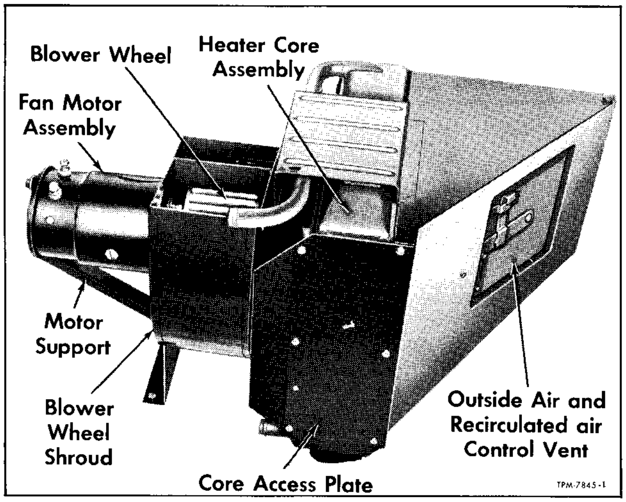


Figure 26—Defroster Heater Removed

position by four winged fasteners.

Clogged filters restrict air circulation, thus reducing efficiency of system. In addition to the effect on system operation, dirty filters permit dirt to pass into the core clogging coil and fins.

Filter elements are of disposable type. Filters should be removed weekly and if they appear to be dirty or restricted they should be replaced.

To remove filter sections, open access door, then using thumb pressure or a small screwdriver as shown in figure 25, pry center section upward against tension and pull lower end rearward from channel. Slide end sections toward center of coach, then remove.

Dirty elements can be pulled from frame channels and new elements installed. After installing, make sure filter sections are seated firmly in channel and no space exists between sections.

DEFROSTER HEATER

Defroster heater assembly is located in compartment at front center of dash. Assembly consists of fan motor, a fan wheel and shroud assembly, heater core unit and air inlet duct with damper door. Figure 26 shows heater core assembly removed. Access to heater assembly is gained after removing dash center closure panel.

The heater motor can be removed after removing attaching screws and the heater core only can be removed after disconnecting heater lines, removing core access plate, then pulling core from heater unit.

Heater fan motor is of two speed type and is controlled by "DEFROST" switch on control panel at left of driver. Whenever the switch is placed in "HI" or "LO" position the heating system water pump becomes operative, circulating engine coolant through the defroster heating system.

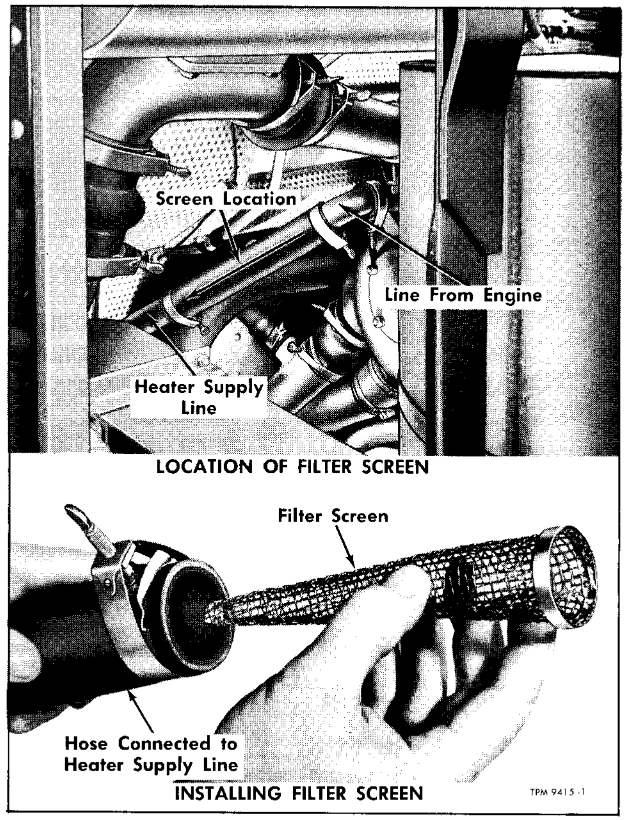


Figure 27—Heater Supply Line Filter Screen

Flow of water through the heater core is controlled by driver by positioning of heater supply shut-off valve control knob. Knob is located behind dash panel at right of operator (fig. 8). Pull knob up to increase heat.

IMPORTANT

EXCESSIVE USE OF DEFROSTER HEATER WILL CAUSE HIGH TEMPERATURE AT THE FRONT END OF COACH, THEREBY SATISFYING THE GRAD-U-STAT AND LEAVING THE BALANCE OF COACH COLD.

HEATER LINE WATER FILTER SCREEN

Heater water filter screen, located in heating system water supply line hose at engine water manifold, should be removed and cleaned whenever water system is drained. Filter screen is easily removed from hose after removal of hose clamps and then disconnecting hose. Figure 27 shows screen location and proper positioning of screen when installing.

NOTE: If rubber connection hose is collapsed, or deteriorated, it should be replaced at this time.

HEATING AND VENTILATION

TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSES
UNDER-HEATING (Items with an asterisk (*) also apply to under-cooling)	Grad-U-Stat setting too low. *Grad-U-Stat out of calibration. *Grad-U-Stat valve unit sticking or damaged. *Water modulation valve stem bent or sticking. *Foreign material in water modulation valve body. *Blowers inoperative. *Air filters dirty. Heater cores dirty. *Proportion of outside air admitted too high. *Clogged recirculated air inlet screen. Heater line gate valve closed. Air in heater system water lines. Excessive heat at dash heater. UNDER-COOLING ONLY: Grad-U-Stat setting too high. Pressure regulator valve setting too low. Leakage in air lines and fittings.
OVER-HEATING (Items with an asterisk (*) also apply to over-cooling)	Grad-U-Stat setting too high. *Grad-U-Stat out of calibration. *Grad-U-Stat valve unit sticking or damaged. Pressure regulator valve setting too low. Leakage in air lines and fittings. Defective diaphragm in water modulation valve. Outside air intake restricted. OVER-COOLING: Grad-U-Stat setting too low.
ALTERNATE UNDER- AND OVER-HEATING	Water modulation valve stem bent or sticking. Throttling range setting of Grad-U-Stat too low. (Also applies to alternate over- and under-cooling.)

NOTE: Throttling range setting of 6°F. is recommended for Grad-U-Stat.

SPECIFICATIONS

UNDERFLOOR HEATER BLOWER MOTORS (With Air Conditioning)
GM Part No. 5549149
Make .... Delco Products
H.P. 3/4
Volts 13.5
Rotation (Commutator End) .... Clockwise
RPM .... 1750 (Low Speed)
.... 2250 (High Speed)

UNDERFLOOR BLOWER MOTORS (Without A/C)
GM Part Number 1114642
Make .... Delco-Remy
Volts 13.5
Rotation (Shaft End) .... CCW
H.P. 3/8
RPM (Under Load) 2500
Amps (Under Load) .... 35 to 37

DASH HEATER BLOWER MOTOR
GM Part Number 1114615
Make .... Delco-Remy
Volts 12
Rotation .... C.W.

DASH HEATER BLOWER MOTOR—(Continued)
Type .... 2 Spd.
RPM .... 2200 and 1400
H.P. .... 1/5 @ 2200 RPM

WATER PUMP MOTOR
GM Part Number 2397746
Make .... Marine Products Co.
Volts 13.5
Amps .... 8.5 to 9.5
Rotation (Drive End) .... CCW
RPM 3000

GRAD-U-STAT
GM Part Number 2340294
Make .... Minneapolis Honeywell
Model .... TP 900 F1032

WATER MODULATION VALVE
GM Part Number 2389439
Make .... Minneapolis Honeywell
Model VP511A1016
Starts to Close .... 3 ± 3/4 psi
Completely Closed .... 12 ± 3/4 psi

Brakes

This group is divided into five sections as shown in index below:

AIR SYSTEM EQUIPMENT

4

The coach air system is made up of a group of devices. Some of these devices maintain a supply of compressed air. Others direct and control the flow of this compressed air. Still other devices, directly connected with the braking function, are operated by compressed air. Only those units with functions directly related to vehicle braking system are covered in this group. Information on all units in air system will be found in sections of this manual as shown below in "Index of Air Control Units."

INDEX OF AIR CONTROL UNITS

Air Brakes

BRAKE SYSTEM OPERATION

Compressed air is discharged into the main (wet) air tank and flows from the wet tank into the second main (dry) air tank. There are two tee connections and two single connections at dry air tank. Lines from one tee lead to air compressor governor and to suspension air tank. Lines from second tee lead to rear brake relay valve and to door controls, air gauge, and windshield wipers. Air line at one single connection comes from wet air tank. Line at other single connection leads to air brake application valve.

Moisture ejector valves are used on some vehicles to automatically remove accumulated moisture from wet air tank. Valves are operated

by compressed air when brakes are released, or when governor unloads air compressor. Valve opens and allows accumulated moisture at bottom of tank to be blown out through two drain tubes.

Pressure regulating valves are installed in air lines leading to suspension air tank and to windshield wipers. Valves admit air only when main tank pressure is 65 psi or over. Valves prevent pressure in main air system from dropping below a safe limit due to leaks or to use of windshield wipers with engine stopped. Check valve in suspension air tank inlet line prevents loss of suspension air back into main air system.

Low air pressure switch closes an electrical circuit in the tell-tale alarm system when main tank pressure is below switch setting. This causes the tell-tale alarm buzzer to sound and the "LOW AIR" tell-tale to light.

When brakes are applied, air pressure passes through the brake application valve to the front brake chambers and to rear brake relay valve and stop light switch. Air to relay valve actuates the valve, permitting compressed air direct from main tank to pass through the valve to rear brake chambers.

When brakes are released, air in the rear brake chambers is exhausted at the relay valve. Air in front brake chambers and in line leading to relay valve is exhausted at brake application valve.

BRAKE SYSTEM MAINTENANCE

Procedures for testing, adjusting, and overhauling brake system units are described under individual headings later in this section.

Air compressor discharge muffler and air tanks without moisture ejector valve should be drained daily. Refer to "Air Tanks" later in this section for location of tanks and drain cocks.

The complete air system should be checked for leakage at regular intervals. With engine stopped and brakes released, observe rate of air pressure drop registered by the dash gauge. The rate of drop should not exceed two pounds per minute. With engine stopped and brakes fully applied, observe the rate of air pressure drop registered by the dash gauge. Rate of drop should not exceed three pounds per minute. If leakage is excessive, leakage tests should be made at air line connections and at all air brake control units as directed under individual headings later in this section.

Drain moisture regularly from air system, especially during cold weather. When necessary to protect air system against extreme cold weather operation, install an alcohol evaporator to feed alcohol vapor into the system.

Refer to "AIR COMPRESSOR AND GOVERNOR" section later in this group for information on air compressors and governors.

BRAKE ADJUSTMENTS

BRAKE SHOE ADJUSTMENT

Brake adjustment for normal lining wear is made by turning slack adjuster worm shaft (fig. 28). Brake chambers and slack adjusters installed are shown in figures 29 and 30. Brake chamber push rod travel should be checked after every 2000 miles of operation to determine whether adjustment is necessary. While maximum travel, listed in "Specifications" at end of this section, is permissible, travel should be maintained as short as possible without brakes dragging for braking efficiency and economy in air consumption. Brake linings should be replaced when worn to a thickness of 5/16" at center of shoe.

1. Always check wheel bearing adjustment and correct if necessary before attempting to adjust brakes. Refer to "HUBS AND BEARINGS" (SEC. 19) of this manual.

2. With wheel jacked up, turn slack adjuster worm shaft until brake drags, then back off until wheel turns freely. NOTE: Lock sleeve must be pushed in before worm shaft can be turned. Make sure sleeve is pushed in far enough to clear hex end of worm shaft before turning shaft.

3. Be sure wheel turns freely with no brake drag when brakes are fully released. After completing adjustment, make sure lock sleeve comes out and engages hex end of worm shaft. Pry sleeve out with screwdriver if necessary. Coat lock sleeve and end of worm shaft with wheel bearing grease after completing adjustment. This keeps out dirt and water, and assures free movement of sleeve at next adjustment.

BRAKE TREADLE ADJUSTMENT

1. Push brake treadle down to limit of travel.

2. Loosen treadle stop screw lock nut.

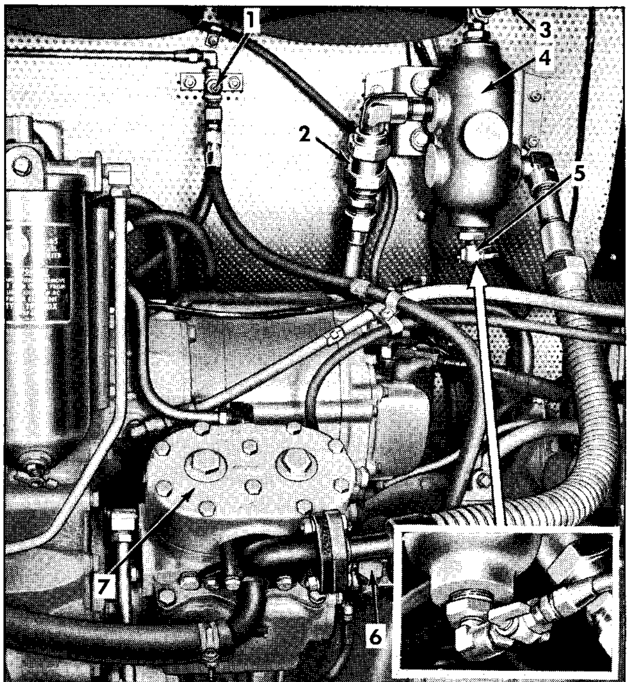
3. Turn stop screw to a height of approximately 3.80" from floor.

4. From full down position, raise brake treadle two full turns of stop screw. This clearance protects brake application valve parts from damage.

5. Adjust adjusting screw (3, fig. 17 or 24, fig. 18) to provide 0.001" to 0.002" clearance between treadle roller and plunger with treadle held tight against adjusting screw. Tighten lock nut firmly.

AIR COMPRESSOR DISCHARGE MUFFLER

Air compressor discharge muffler (figs. 1 and 2), mounted in engine compartment above transmission, is connected by a flexible air line to the air compressor discharge fitting. Purpose of muffler is to arrest the pulsation noises (ping) caused



1 Filler Valve
2 Check Valve
3 Safety Valve
4 Discharge Muffler
5 Drain Cock
6 Compressor Governor
7 Air Compressor

TPM-9269

Figure 1—Bendix-Westinghouse Air Compressor and Discharge Muffler Installed

by discharge of compressed air from the reciprocating air compressor.

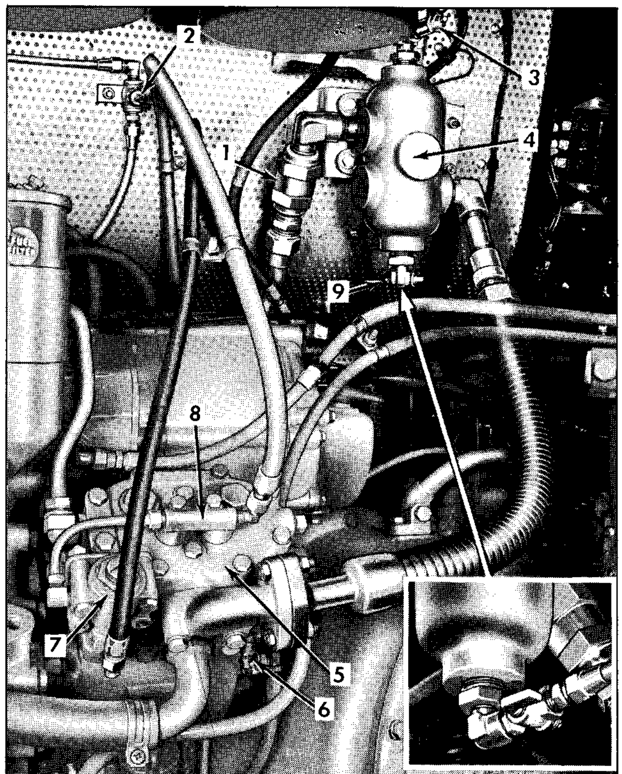
Since the discharge muffler is the first unit the hot compressed air enters, considerable condensation collects in the unit. This condensation must be drained daily. Drain cock and drain tube are installed at lower side of muffler. Drain cock is open with handle at right angle to body, and is closed with handle parallel to body.

Muffler should be removed at regular intervals and the inside cleaned of carbon deposits or other foreign material.

CHECK VALVE

DISCHARGE LINE CHECK VALVE

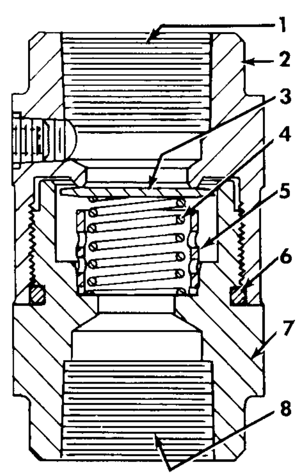
One-way check valve (fig. 3) is installed in air compressor discharge line at the outlet of the compressor discharge muffler (figs. 1 and 2). Check valve may also be installed at dry tank in air line between wet and dry tanks. This valve functions in the air system as a safety device. In the event of leakage or breakage in air compressor to muffler air line, check valve prevents loss of air pressure from the air system. Check valve should be removed, disassembled, and cleaned at regular intervals. Valve disc should be turned over if worn on one side, and a new seal ring should be used when assembling. Install valve to permit air flow in direction of arrow on valve body.



1 Check Valve
2 Filler Valve
3 Safety Valve
4 Discharge Muffler
5 Air Compressor
6 Drain Cock
7 Compressor Governor
8 Unloader Assy.
9 Drain Cock

TPM 8798

Figure 2—Midland-Ross Air Compressor and Discharge Muffler Installed



1 Air Inlet
2 Valve Cover
3 Valve Disc
4 Valve Spring
5 Spring Cage
6 Seal Ring
7 Valve Body
8 Air Outlet

TP-5999

Figure 3—Compressor Discharge Line Check Valve

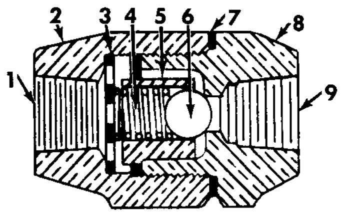


Figure 4—Suspension Air Tank Check Valve

SUSPENSION AIR TANK CHECK VALVE

Suspension air tank check valve (fig. 4) is a ball type check valve installed at suspension air tank inlet. Check valve prevents loss of air pressure from suspension air tank in the event of pressure loss from the main air system. Check valve should be removed, disassembled, and cleaned at regular intervals. Check valve ball should be replaced if any wear or roughness is evident. Use new gasket between valve cap and body when assembling valve. Install valve to permit air flow into suspension air tank as indicated by arrow stamped on valve cap.

AIR TANKS

Three air tanks are used in Transit Coach air system, two main tanks and the suspension air tank. On Suburban models, four air tanks are used in vehicle air system, two main tanks, front brake air tank, and suspension air tank.

These tanks provide an ample supply of compressed air that is available for immediate operation of the brakes, air suspension system, and other air-operated equipment. Tanks store sufficient compressed air for several brake applications with the engine stopped.

Air tanks also serve to cool and condense oil and water vapors in compressed air. Most of this condensation takes place in the main (wet) air tank, the tank connected to the air compressor. The moisture ejector valve (fig. 9 or 11), when used, automatically drains condensation from tank each time air compressor governor operates the compressor unloader, or each time the brakes are applied and released (depending upon the type of ejector system used). The dry air tank, suspension air tank, and front brake air tank on Suburban models, must be drained manually each day. Drain tanks completely by leaving drain cocks open after all air is exhausted and until all drainage stops.

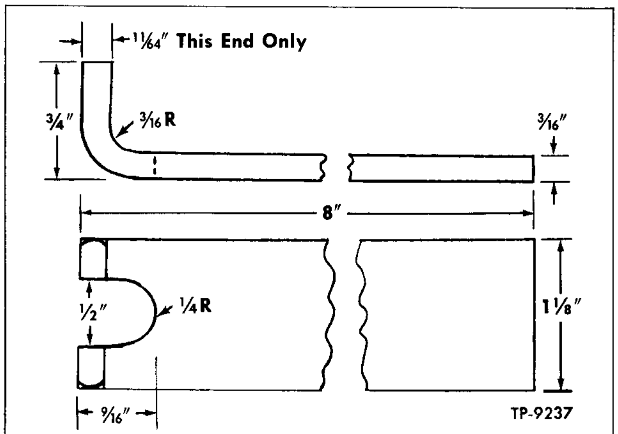


Figure 5—Special Tool For Recessed Type Drain Cock

On Transit Coaches, the wet air tank is mounted horizontal on left-hand side of coach behind the batteries. The dry air tank is mounted horizontal at right side of wet air tank. Suspension air tank is mounted horizontal ahead of wet air tank on left side of coach. All air tanks are located below coach floor. On Suburban Coaches, the wet air tank is mounted vertical on left side of coach behind the batteries. The dry air tank is mounted vertical beside wet air tank. Suspension air tank is mounted horizontal ahead of the wet and dry air tanks on left side of coach. Front brake air tank is mounted horizontal beneath driver's seat. NOTE: On Suburban coaches with baggage compartment, suspension air tank is mounted in rear bay at right rear of coach. All air tanks are located under coach floor. On some air tanks, drain cocks at bottom of tanks are recessed key type. A special tool must be used to open and close drain cocks. Tool can be made locally to dimensions shown in figure 5.

All air tank mounting bolts should be checked for looseness at regular intervals and tightened if necessary. Air tanks may be cleaned inside and out using steam or hot water. Inspect tanks for corrosion or other damage. If corrosion or other damage has weakened a tank, it must be replaced.

Schematic diagrams of air system showing air tanks, standard air supply and brake system units, and suspension air system are shown in figures 6 and 7. The open lines represent air supply and air brake system air lines. The solid black lines represent air suspension air lines. A more detailed diagram of the suspension air system is shown in AIR SUSPENSION (SEC. 14) of this manual.

SAFETY VALVE

Key numbers in text refer to figure 8.

Safety valves, shown in figure 8, are installed in the wet air tank and discharge muffler to prevent air pressure build-up in the air system beyond a set maximum.

OPERATION

When reservoir pressure is built up to exceed 150 pounds, force of air pressure forces ball (3) off seat (2), permitting air pressure in excess of

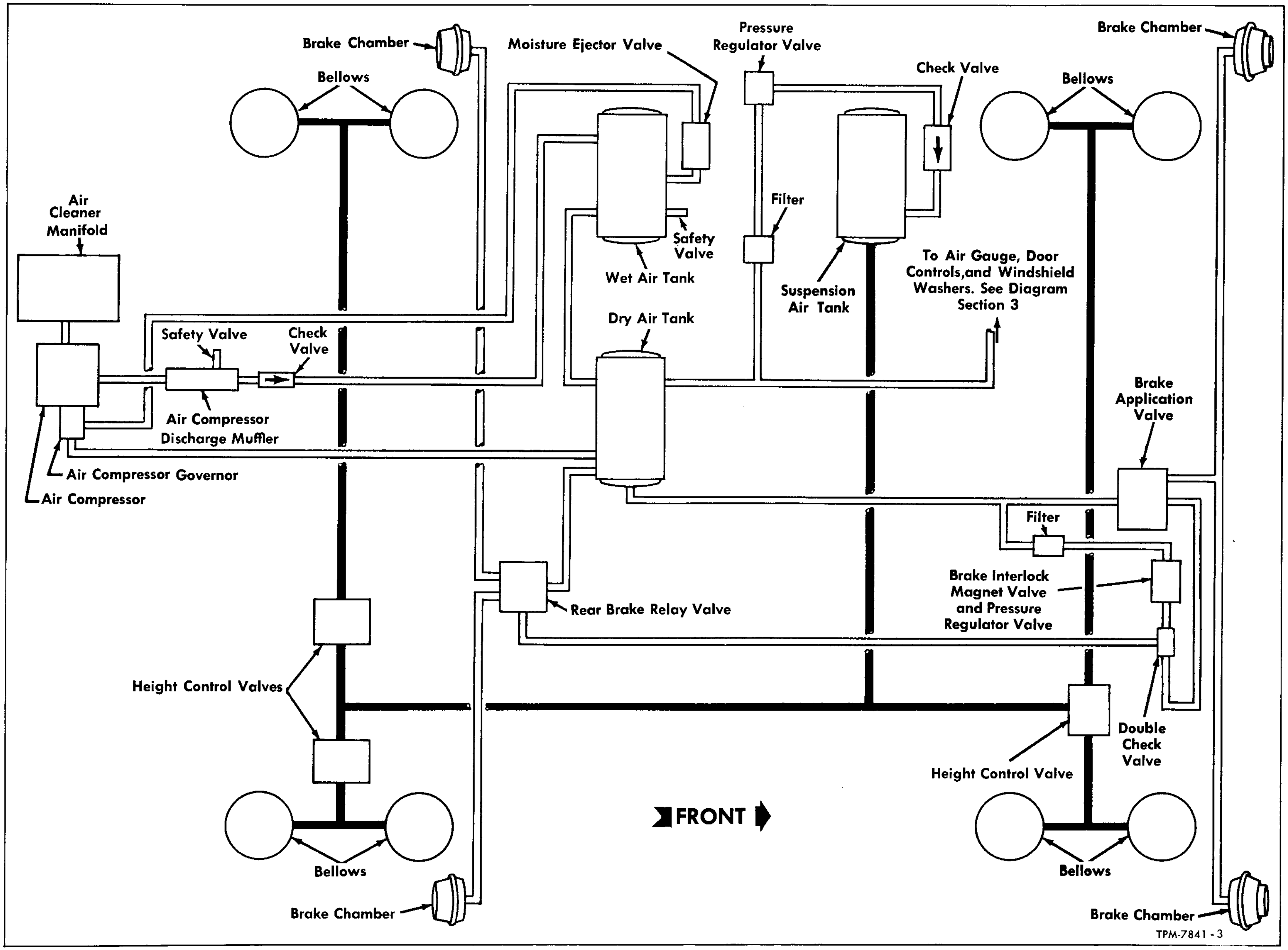
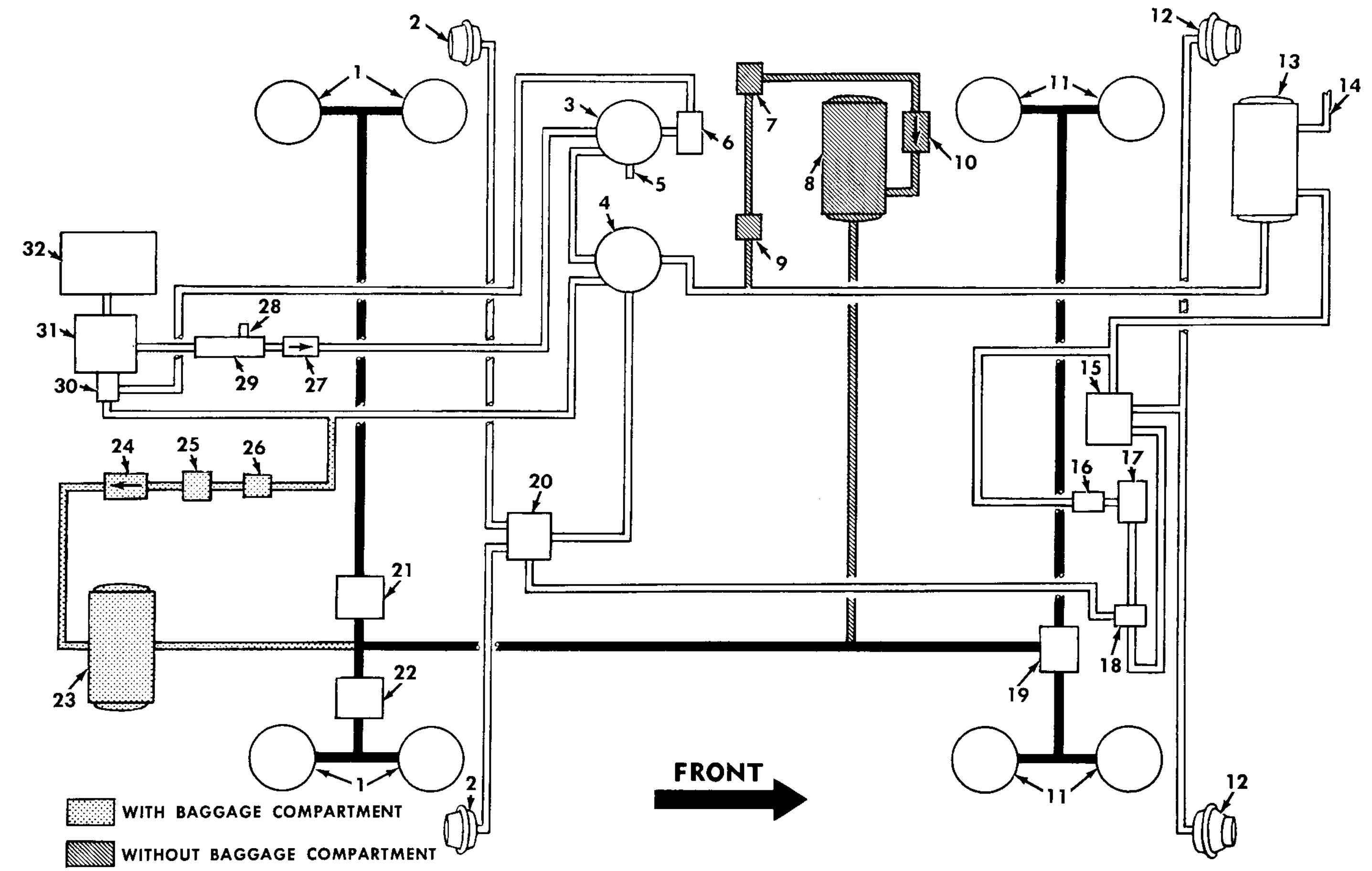


Figure 6—Typical Schematic Air Line Diagram—Transit Coaches



1 Rear Bellows
2 Rear Brake Chambers
3 Wet Air Tank
4 Dry Air Tank
5 Safety Valve
6 Moisture Ejector Valve
7 Pressure Regulator Valve
8 Suspension Air Tank
9 Filter
10 Check Valve
11 Front Bellows
12 Front Brake Chambers
13 Front Brake Air Tank
14 To Air Gauge, Door Controls, and Windshield Washers (See Diagram, Section 3)
15 Brake Application Valve
16 Filter
17 Brake Interlock, Magnet Valve, and Pressure Regulator Valve
18 Double Check Valve
19 Height Control Valve
20 Rear Brake Relay Valve
21 Height Control Valve
22 Height Control Valve
23 Suspension Air Tank
24 Check Valve
25 Pressure Regulator Valve
26 Filter
27 Check Valve
28 Safety Valve
29 Air Compressor Discharge Muffler
30 Air Compressor Governor
31 Air Compressor
32 Air Cleaner Manifold

TPM-9433

Figure 7—Typical Schematic Air Line Diagram—Suburban Coaches

150 pounds to escape through exhaust port (4) to atmosphere. After pressure bleeds down, spring (5) forces ball (3) back on seat (2).

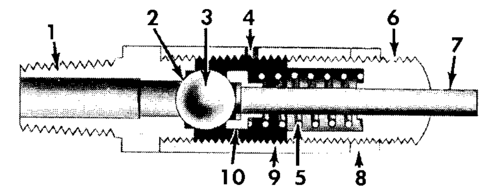
MAINTENANCE

Check safety valve periodically for leakage, using soap suds at exhaust port. Leakage should not exceed a 1-inch bubble in 5 seconds. Once a year, valve should be dismantled, cleaned with kerosene, and reset to blow off at 150 pounds.

ADJUSTMENT (Fig. 8)

Set safety valve in following manner:

1. Loosen lock nut (8).
2. Adjust set pressure by turning adjusting nut (6). Turn nut clockwise to increase pressure, or counterclockwise to decrease pressure.
3. Tighten lock nut (8) firmly.



1 Body
2 Ball Seat
3 Ball Valve
4 Exhaust Port
5 Spring
6 Adjusting Screw
7 Stem
8 Lock Nut
9 Spring Cage
10 Spring Seat

TPM-8579

Figure 8—Safety Valve

MOISTURE EJECTOR VALVE (EXPELLO)

DESCRIPTION

The "Expello" moisture ejector valve (fig. 9) is operated by compressed air and automatically ejects condensation from the wet air tank. The valve is connected to bottom of wet air tank. Condensation drains into valve upper body. An optional heating coil, when used, prevents moisture from freezing. Heating coil is connected to No. 18 circuit breaker behind control panel at left side of driver's seat.

OPERATION

The air line at lower body of ejector valve comes from rear brake relay valve exhaust port. Moisture is ejected each time brakes are released. Exhaust air pressure from relay valve momentarily lifts diaphragm and raises valve off seat in upper body. During this interval air pressure in tank forces moisture out through discharge port.

SERVICEABILITY TESTS

1. Operating Tests

Ejector valve can be operated manually or by applying and releasing brakes.

Manual Operation. Push up projecting end of stem assembly. As valve unseats, moisture is forced from air tank through condensate discharge port.

Brake Operation. Apply and release brakes. As brakes are released, exhaust air from rear brake relay valve operates ejector valve.

2. Leakage Test

With brakes applied, coat bottom of ejector valve with soap suds. If bubbles appear at air exhaust port, leakage in rear brake relay valve is indicated. If bubbles appear at condensate discharge port, leakage is indicated at valve seat in valve upper body. Valve should be disassembled and seat should be cleaned or repaired, or complete valve assembly should be replaced.

EJECTOR VALVE REPLACEMENT

Removal

Exhaust compressed air from system. Disconnect air line from valve lower body. Disconnect wire from valve heating coil lead (if used). Unscrew valve assembly from bottom of air tank.

Installation

Thread ejector valve assembly into bottom of air tank and tighten firmly. Connect wire to heating coil lead (if used). Connect air line to opening in valve lower body. Build up air pressure in system and test valve as previously directed under "Serviceability Tests."

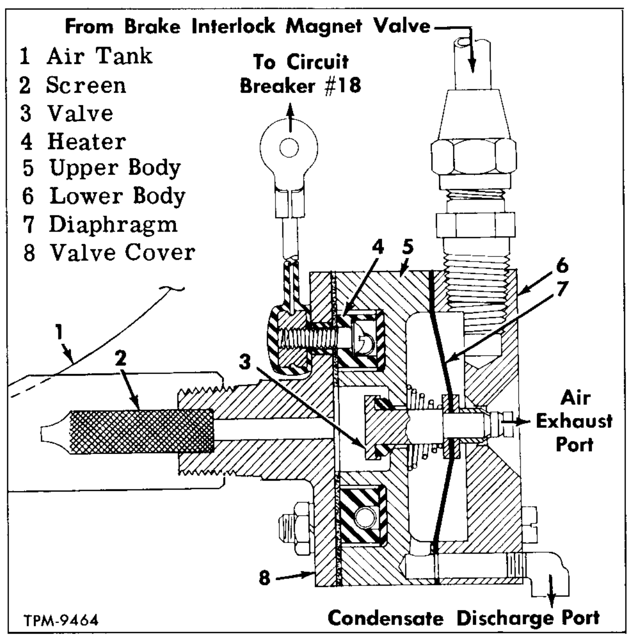


Figure 9—Moisture Ejector Valve (Expello)

EJECTOR VALVE OVERHAUL

Key numbers in text refer to figure 9.

Disassembly

1. Remove four nuts and lock washers from valve body bolts. Mark valve cover (8) and upper (5) and lower (6) bodies to aid in assembly.

2. Lift off valve cover and heater assembly. See "Inspection and Repair" for method of checking wire assembly and heating element. Carefully remove two brass screws from heating insulator. Remove wire assembly, heating element and insulator, and asbestos gasket. Remove insulating washer from cover.

3. Separate upper and lower bodies and remove four bolts. Remove asbestos gasket from upper body.

4. Cut off small end of stem at second groove. The sleeve that holds assembly together is swaged as shown in figure 9. Remove sleeve from end of valve stem. Remove brass washer, diaphragm (7), second brass washer, and spring. Remove stem from opposite side of upper body.

Inspection and Repair

1. Check electrical resistance through wire assembly and heating element before removing these parts from cover. Use a 12-volt source. With parts in good condition, resistance will be approximately 7 ohms.

2. Discard stem assembly parts and gaskets.

3. Clean all parts. Use reseating tool CVT-8, if necessary, to clean and restore valve seat. Do not re-use upper body if more than 1/32" has been taken off height of seat.

4. Inspect screen for looseness or signs of damage. If necessary, solder new screen in place.

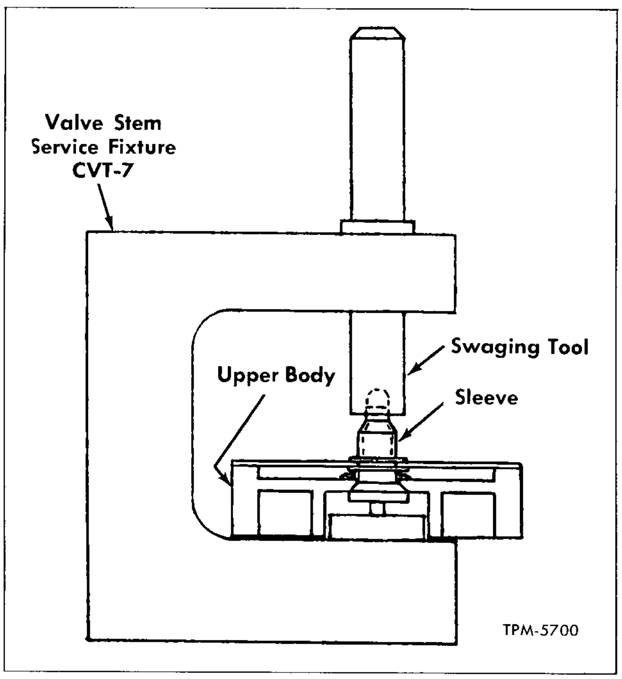


Figure 10—Installing Valve Stem Sleeve

Assembly

1. Remove any excess rubber from new stem. Install stem in cover side of upper body (5). Place spring over stem, with large diameter against upper body (5). Install brass washer, diaphragm (7), and other brass washer on stem. Install sleeve, large end first, over end of stem and swage as follows:

a. Hold assembly together and carefully position large end of stem on anvil of valve stem service fixture CVT-7 as shown in figure 10.

b. Place swaging tool over small end of stem and sleeve. Lift edge of diaphragm (7) and check position of spring. Edge of spring should not prevent parts from fitting together squarely on stem.

c. Tap shoulder lightly with a hammer until shoulder of tool rests on top of fixture. This will lock diaphragm tightly in place.

Small end of sleeve should be forced tightly enough into stem groove to prevent air leakage at diaphragm (7). To prevent damage to parts, avoid excessive pressure.

2. Place asbestos gasket on cover (8) with screw holes in gasket aligned with screw holes in cover. Insert insulating washer in screw hole in cover.

3. Position insulator, with grooved side exposed, on gasket. Attach insulator loosely with small brass screw. Hold wire assembly opposite screw hole and attach loosely with long brass screw. Insert one end of heating element under head of small screw. Tighten snugly. Overtightening could crack insulator. Stretch element around groove and insert other end under head of large screw. Tighten snugly.

4. Rotate diaphragm (7) until all holes are properly aligned. Diaphragm must not cover condensate discharge port. Place upper body (5) on lower body (6). Place asbestos gasket in upper body.

5. Place cover (8) in position on upper body (5). Use alignment marks made previously. Install four bolts in holes in lower body (6). Place four lock washers and nuts on bolts. Align cover (8), upper body (5) and lower body (6). Stem should be in a central position. Tighten nuts firmly enough to prevent air leaks.

MOISTURE EJECTOR VALVE (GRAHAM-WHITE)

DESCRIPTION (Fig. 11)

The moisture ejector valve is bolted to a bracket above wet air tank and beneath coach floor. Valve may also be located above floor and behind

access cover in air duct. Most of the condensation takes place in the wet air tank. This condensation is automatically drained through the ejector valve.

OPERATION

Moisture ejector valve operates each time the governor unloads the air compressor or door control is actuated, depending on type of installation. Air pressure from governor or door control works against ejector valve cup. This force moves piston, compresses valve spring, and unseats exhaust valve. Air pressure in wet air tank forces accumulated moisture into valve and out through two drain lines. At end of piston stroke, opposite seat makes contact and closes valve.

SERVICEABILITY TESTS

1. Operating Test

On governor operated system, build up tank pressure in air system; at cut-out point (120 psi), air pressure from governor unloads compressor and also operates ejector valve. On door operated system, operate door control to check operation of ejector valve.

2. Leakage Test

Coat open end of both drain lines with soap solution. The presence of soap bubbles will indicate leakage past valve seat. Disassemble unit and clean or replace exhaust valve.

EJECTOR VALVE REPLACEMENT

Removal

1. Exhaust compressed air from the system.
2. On vehicles with ejector valve mounted in air duct above floor, remove access panel from air duct (ahead of left rear wheelhouse).
3. From under coach or in air duct above floor (depending upon valve location), disconnect air lines from ejector valve.
4. Remove bolts attaching ejector valve to bracket and remove valve assembly.

Installation

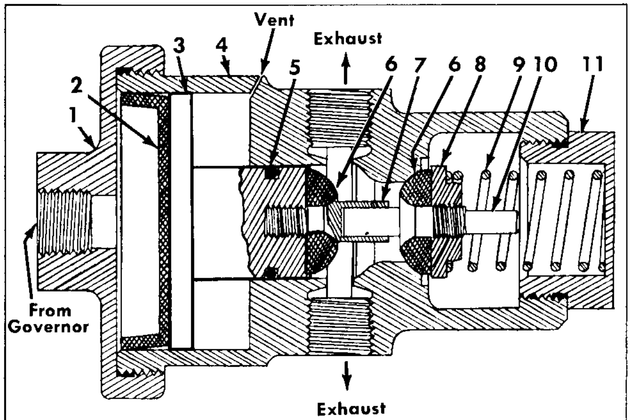
1. Position ejector valve at mounting bracket, either from under coach or in air duct above floor (depending upon valve location), and attach with two bolts and lock washers.
2. Connect air lines to ejector valve; tighten connections firmly.
3. Build up air pressure in system and test ejector valve as previously directed under "Serviceability Tests."
4. On vehicles with ejector valve mounted in air duct above floor, install access panel on air duct.

EJECTOR VALVE OVERHAUL

Disassembly

Key numbers in text refer to figure 11.

1. Unscrew spring cap (11) and remove from valve body (4).
2. Remove valve spring (9) and intake valve assembly, consisting of seat (6), seat washer (8), and valve stem (10) as an assembly, from valve body.
3. Turn seat washer (8) off valve stem (10). Remove seat (6) from valve stem (10).
4. At opposite end of the assembly, unscrew cylinder cap (1) and remove from valve body (4).
5. Push on piston stem (7) and remove cup (2), piston (3), O-ring (5), seat (6), and piston stem (7) from valve body (4).
6. Unscrew piston stem (7) from piston. Remove seat (6).
7. Remove O-ring (5) from piston and discard.



1	Cylinder Cap	7	Piston Stem
2	Cup	8	Seat Washer
3	Piston	9	Valve Spring
4	Body	10	Valve Stem
5	O-ring	11	Spring Cap
6	Seat		

TPM-7201

Figure 11—Moisture Ejector Valve (Graham-White)

Inspection

1. Clean all parts thoroughly with cleaning solvent. Wipe or blow parts dry.
2. Examine cylinder cap, valve body, and spring cap for cracks, stripped threads, or other damage.
3. Check vent in valve body for obstruction.
4. Inspect valve cup, piston, seat washer, and seats for wear or damage.
5. Check valve stem and piston stem for distortion, stripped threads, or other damage.
6. Inspect valve spring for free length, compressed length, distortion, or collapsed coils.

Assembly

Key numbers in text refer to figure 11.

1. Install a new O-ring (5) in groove of piston (3).
2. Position seat (6) to piston (3); then thread

piston stem (7) into piston (3).

3. Insert piston assembly in valve body (4).

4. Install cup (2) in body (4); then thread cylinder cap (1) on valve body. Tighten firmly.

5. Position seat (6) on valve stem (10); then thread seat washer (8) on stem.

6. Install intake valve assembly, consisting of parts assembled in step 5 above, in valve body (4).

7. Position valve spring (9) against seat washer (8) in valve body.

8. Thread spring cap (11) into valve body (4). Tighten cap firmly.

AIR LINES

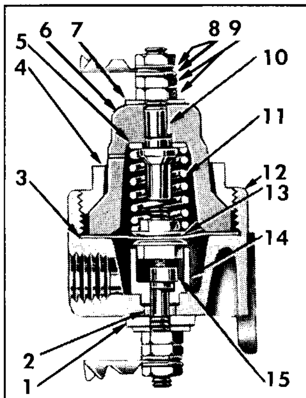
Metal tubing and flexible hose are used to connect the various units of the air brake system. Service instructions for both types follow:

METAL TUBING

Metal air lines are of annealed copper tubing with three-piece compression type fittings. Flared type fittings should never be used in air brake systems. Connections should be tested for leakage at least every 5,000 miles and tightened or replaced if necessary. When replacing metal tubing, tubing must be free of burrs, copper cuttings, and dirt. Blow out with compressed air. Any of the above mentioned particles will destroy sealing seats in air control units. New tubing must be of the same size as the old tubing.

FLEXIBLE HOSE

Flexible hose is used at each brake chamber where it is impossible to use metal tubing due to constant flexing during vehicle operation. Hose connections should be tested for leakage at least every 5,000 miles and tightened or replaced if necessary. Any hose which is chafed, worn, or kinked should be replaced.



1 Terminal Washer
2 Grommet
3 Diaphragm Assembly
4 Cover Retainer
5 Washer
6 Cover
7 Clamping Washer
8 Washers
9 Nuts
10 Terminal Screw
11 Spring
12 Body
13 Shims
14 Terminal Bushing
15 Terminal Screw

TP 5468

Figure 12—Low Air Pressure Switch (Bendix-Westinghouse)

SERVICEABILITY TESTS

1. Operating Test

If any trouble symptom such as slow brake application or slow brake release indicates restricted or clogged air line, disconnect the suspected tube or hose at both ends and blow through it to make sure the passage is clear. Inspect tubing and hose for partial restriction such as would be caused by dents or kinks. If such a condition is found, tubing or hose should be replaced.

2. Leakage Test

With air system fully charged and brakes applied, coat all tubing and hose connections with soap suds to check for leakage. No leakage is permissible. Leakage can sometimes be corrected by tightening the connection. If this fails to correct leakage, new fittings, metal tubing, or flexible hose must be installed.

AIR PRESSURE GAUGE

The air pressure gauge in the instrument panel is connected into the air line leading from second main (dry) air tank.

The vehicle should never be put in motion until the air pressure registers at least 60 pounds. If pressure drops below 60 pounds (low pressure buzzer sounds), stop vehicle immediately and determine cause of pressure loss. Check gauge regularly with an accurate test gauge. Replace with a new unit if reading varies four pounds.

LOW AIR PRESSURE SWITCH (BENDIX-WESTINGHOUSE)

Low air pressure switch (fig. 12) is a safety device designed to automatically give a warning when pressure in air system falls below a safe limit for brake operation. The low air pressure switch is actually an air-controlled switch in an electrical circuit, automatically controlling a telltale light and buzzer. Operation of tell-tale alarm system is explained in "WIRING AND MISCELLANEOUS ELECTRICAL" in ELECTRICAL (SEC. 7). Low air pressure switch is mounted near door control valve at left of driver, and is connected into the feed line to the door control valve. Refer to "Alarm and Signal Wiring Diagram" in back of this manual for electrical circuits.

OPERATION (Fig. 12)

When system air pressure under the diaphragm is about 60 pounds, force exerted by air pressure overcomes the force exerted by the diaphragm spring, and the electrical contacts remain open.

When the air pressure drops below 60 pounds, diaphragm spring exerts a force above the dia-

phragm which is greater than force exerted by the air pressure below the diaphragm. This will cause the diaphragm to move down and close the electrical contacts. This completes electrical circuit to buzzer and tell-tale light, informing driver of his impending loss of air pressure.

The nominal pressure setting of 60 pounds is subject to a tolerance of plus 5 pounds so that actual operating pressure of the low air pressure switch may vary between 65 pounds maximum and 60 pounds minimum.

SERVICEABILITY TESTS

1. Operating Test

Operation of the low air pressure switch may be checked by reducing the system pressure and being sure that the contacts close when reservoir pressure is between 65 pounds maximum and 60 pounds minimum. The contacts will be closed when the tell-tale light and electrical buzzer operate.

2. Leakage Test

A small vent hole is provided in cover of the low air pressure switch to check condition of the diaphragm. Cover vent hole with soap suds. If a leak is indicated it signifies a ruptured diaphragm. The diaphragm should then be replaced.

LOW AIR PRESSURE SWITCH REPLACEMENT

Removal

1. Exhaust air pressure from main air system.
2. Disconnect wires from terminals at top and bottom of switch and disconnect air line from switch.
3. Remove two screws attaching switch and remove switch assembly.

Installation

1. Position switch and attach with two screws.
2. Connect wires to switch terminals.
3. Connect air line to opening in switch body.
4. Build up air pressure in system and test switch as previously directed under "Serviceability Tests."

LOWER PRESSURE SWITCH OVERHAUL

Key numbers in text refer to figure 12.

Disassembly

1. Unscrew cover retainer (4) from body (12).
2. Remove cover (6) and lift out spring (11), and diaphragm assembly (3).

Cleaning and Inspection

1. Clean all metal parts in cleaning solvent.
2. Examine diaphragm for signs of cracking, wear, or damage. Replace diaphragm if these conditions are found.
3. Inspect contact points for signs of pitting or wear. If pitting is not too severe, contacts may be reconditioned by filing with a fine distributor point file. If they cannot be reconditioned, they should be replaced.
4. Check spring for free length, compressed length, distortion, and collapsed coils. Replace spring if necessary.

Assembly (Fig. 12)

1. Position diaphragm assembly (3) in body (12).
2. Place spring (11) so it will be on the upper diaphragm follower.
3. Place cover (6) over diaphragm (3). Install cover retainer (4) over cover (6) and thread into body (12). Tighten retainer firmly.
4. Test switch as previously directed under "Serviceability Tests." If pressure setting requires adjustment, add or remove shims (13) under spring.

LOW AIR PRESSURE SWITCH (MIDLAND)

The low air pressure switch is designed to complete an electrical circuit when pressure in air system drops below 54 pounds. Completed circuit illuminates a tell-tale light on instrument panel. The switch shown in figure 13 is in normal (cut-out) position with 54 pounds of air or more in system. Pressure is depressing the diaphragm, keeping the contacts separated. When pressure drops, spring on non-pressure side of diaphragm will overcome spring force on pressure side and close contacts. Closed contacts complete circuit and illuminate tell-tale. Light will stay on until pressure builds up to approximately 54 pounds.

SERVICEABILITY TESTS

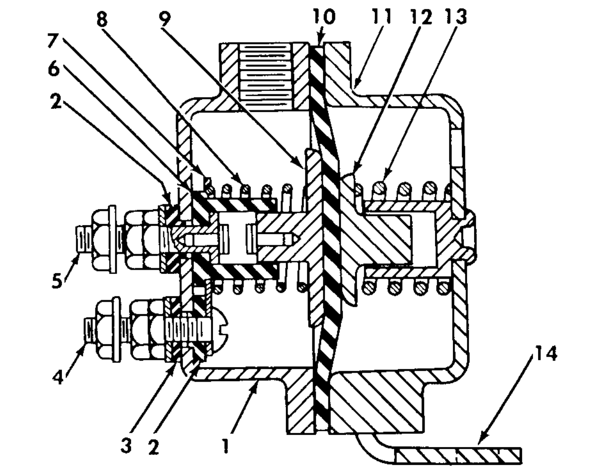
Operating Tests

1. With no air pressure in system, turn ignition switch "ON" and start engine. The low pressure tell-tale must remain on until pressure in air system rises above 54 pounds.
2. Continue to build up pressure in system to at least 60 psi; then stop engine. Slowly exhaust air from system. Note reading on air pressure gauge when tell-tale comes on. Tell-tale should light when pressure falls below 54 psi.

LOW AIR PRESSURE SWITCH REPLACEMENT

Removal

1. Exhaust air from system.
2. Disconnect air line and electrical connections.



1 Body	8 Diaphragm Spring
2 Insulator	9 Contact Plunger Assembly
3 Insulator Washer	10 Diaphragm
4 Terminal Screw	11 Cover
5 Terminal Screw and Contact Assembly	12 Plunger
6 Insulator Base	13 Plunger Spring
7 Terminal Strap	14 Mounting Bracket

TP 5235

Figure 13—Low Air Pressure Switch (Midland-Ross)

3. Remove mounting bolts and remove unit from vehicle.

Installation

1. Position switch to bracket and install mounting bolts.
2. Connect air line and electrical connections.
3. Build up air pressure in system and test unit as previously directed under "Serviceability Tests."

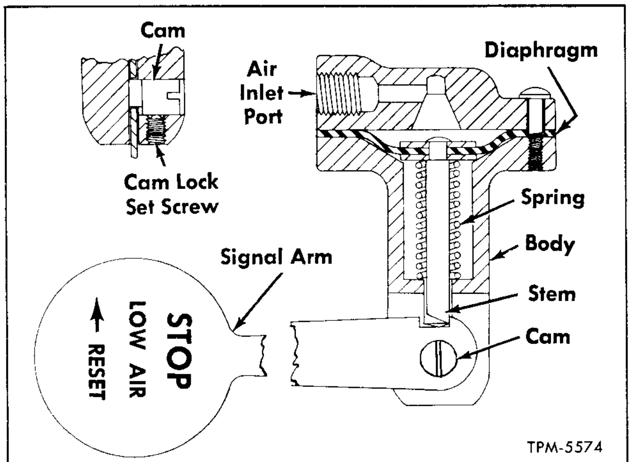


Figure 14—Low Air Pressure Signal

LOW AIR PRESSURE SWITCH OVERHAUL

Disassembly (Fig. 13)

1. Remove screws, nuts, and lock washers attaching cover to body. Separate cover and body; then remove diaphragm. Remove plunger and plunger return spring from cover.
2. Remove contact plunger assembly and diaphragm return spring from body.
3. Remove nut, washer, and insulator washer from each terminal screw. Push screws out of body and remove insulators and terminal strap from screws.

Inspection

A repair kit is available, containing all parts that should be replaced during overhaul. Replace old parts with new parts in kit. Inspect body, cover, springs, and plunger for corrosion. Make sure plunger slides freely in and out of guide cover.

Assembly (Fig. 13)

1. Assemble terminal screws, insulator bushing, insulators, and terminal strap in body with parts positioned as shown in figure 13.
2. Place diaphragm return spring over insulator base in body. Insert contact plunger into insulator base.
3. Place plunger return spring over plunger guide in cover, then insert plunger into guide.
4. Assemble cover and body with diaphragm carefully positioned between the two parts. Tighten screws alternately and evenly.

LOW AIR PRESSURE SIGNAL

The low air pressure signal shown in figure 14 is installed as special equipment on some vehicles. Unit is attached by bracket to windshield header directly in front of driver's seat. When air pressure falls below a safe operating level, signal arm swings down into driver's line of sight as a warning.

OPERATION (Fig. 14)

As the pressure above diaphragm decreases, spring raises diaphragm and stem assembly. Stem is lifted out of notch releasing arm, and arm swings down to a vertical position. Vertical signal arm indicates that air pressure is too low to safely operate air brakes.

Signal arm must be reset by hand after pressure builds up to operating range. As pressure increases above diaphragm, stem is forced downward against signal arm. When arm is moved clockwise to a horizontal position, stem will snap into a locking notch. Arm will lock in a horizontal position as long as operating air pressure is maintained.

SERVICEABILITY TESTS

1. Operating Test

Make a series of brake applications to reduce pressure in air system. As pressure reaches approximately 65 psi, signal arm should swing down to a vertical position. Build up pressure above 65 psi and reset signal arm. Arm should lock securely in place.

2. Leakage Test

Coat cover and lower part of signal body with soap suds. Replace diaphragm assembly if leaks at cover cannot be stopped by tightening cover screws. Leakage of air from body near signal arm also indicates leaky diaphragm. Replace diaphragm assembly.

LOW AIR PRESSURE SIGNAL OVERHAUL

Disassembly (Fig. 14)

1. Mark cover and body to aid in proper assembly. Remove six screws attaching cover to body. Remove cover.

2. Lift diaphragm assembly out of body. Remove spring.

3. Mark position of cam slot on body. Remove set screw locking cam in body. Tap body lightly until cam drops out. Remove signal arm from body.

Inspection

Clean all parts thoroughly. Examine diaphragm for signs of cracks, wear, or damage. Replace diaphragm, if damaged, with new part.

Assembly (Fig. 14)

1. Position signal body so that cam will be in front. Hold signal arm in a horizontal position with notch at right end and on top of arm. Place arm in body slot and align hole in arm with cam hole in body. Insert cam and align slot with mark on body. Install and tighten set screw.

2. Place spring in body. Rotate stem so that taper at bottom slants downward toward right. Install diaphragm and stem assembly. Align holes in diaphragm with holes in body.

3. Align mark on cover with mark on body and position cover on body. Install six screws and tighten firmly.

NOTE: Connect air line to signal inlet port. Apply air pressure. Reset signal as previously explained under "Operation." Bleed pressure down past 65 psi. If signal does not reset and release properly, loosen set screw and adjust cam as necessary. Tighten set screw.

AIR STRAINERS

Three air strainers are used in air lines (fig. 15). One is located at pressure regulator valve, one at brake interlock valve, and one at air suspension pressure regulator valve.

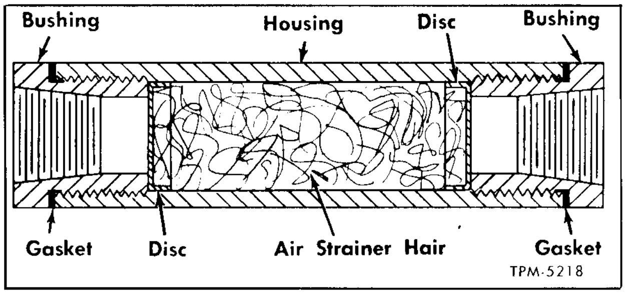


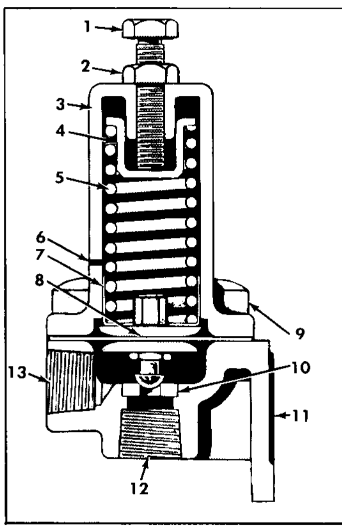
Figure 15—Air Strainer

Strainers should be removed, disassembled, and cleaned yearly. Replace gaskets if necessary. Soak filter material in cleaning solvent. Dry the material and assemble strainers. Tighten bushings firmly.

PRESSURE REGULATING VALVE

Two identical pressure regulating valves (fig. 16) are used, one in the windshield wiper control and door control feed line, the other in the suspension air tank feed line. Windshield wiper pressure regulating valve is mounted at left of driver by the door control valve. Suspension air tank pressure regulating valve is mounted under vehicle between dry air tank and suspension air tank.

Each pressure regulating valve serves two purposes in the air system. One purpose is to prevent air from entering the windshield wiper lines or the suspension air tank until pressure in the main air brake system reaches 65 psi. This provides a rapid build-up of pressure in main air system for operation of brakes. When pressure in



1 Adjusting Screw
2 Lock Nut
3 Cover
4 Spring Seat
5 Spring
6 Vent
7 Dampener
8 Diaphragm and Valve Assembly
9 Screw
10 Valve Seat
11 Body
12 Outlet Port
13 Inlet Port

Figure 16—Pressure Regulating Valve

main air system reaches 65 psi, pressure regulating valves admit compressed air into the windshield wiper lines and into suspension air tank. The second purpose of pressure regulating valves is to prevent a pressure drop in main air system below 65 psi by operating windshield wipers, or by leakage in wiper lines or air suspension system.

SERVICEABILITY TESTS

Test each pressure regulating valve as follows:

1. Operating Test

Exhaust air pressure from air system. Connect a test air gauge in main air system, preferably in the supply line to the pressure regulating valve being tested. Disconnect air line from outlet port at bottom of valve. Build up air pressure in system and note reading on test air gauge when valve permits air pressure to exhaust to atmosphere. If pressure varies more than 5 psi from the original setting (65 psi), the valve requires adjustment.

2. Leakage Test

With air line disconnected from outlet port at bottom of valve and with pressure in main air system just below the valve setting (65 psi), coat the outlet port with soap suds to check for leakage. If leakage is evident, it may be caused by dirt on valve seat or by a worn valve.

ADJUSTING SET PRESSURE

Key numbers in text refer to figure 16.

Pressure at which the valve is unseated is controlled by the adjusting screw (1). Setting may be increased or decreased by turning screw.

1. Connect air pressure gauge as in "Operating Test" above.
2. Back off lock nut (2); then turn adjusting screw (1) clockwise to increase pressure, or counterclockwise to decrease pressure.
3. Tighten lock nut (2) when proper adjustment is obtained.

PRESSURE REGULATING VALVE REPLACEMENT

Removal

1. Exhaust air pressure from air system and disconnect air lines from valve.
2. Remove mounting bolts and remove unit from vehicle.

Installation

1. Position valve assembly on vehicle and attach with two mounting bolts.
2. Connect air lines to valve.
3. Build up air pressure in system and test valve as previously directed in "Serviceability Tests."

PRESSURE REGULATING VALVE OVERHAUL

Key numbers in text refer to figure 16.

Disassembly

1. Remove four screws (9) attaching cover (3) to body (11) and remove cover.
2. Remove spring (5), spring seat (4), and dampener (7) from cover.
3. Lift diaphragm and valve assembly (8) off body.

Inspection

1. Clean all parts thoroughly, using a suitable cleaning solvent.
2. Examine diaphragm for cracks or wear. If either the valve or diaphragm are worn or damaged, a new diaphragm and valve assembly should be installed.
3. Inspect valve seat in body. If seat is pitted, scratched, or chipped, it should be replaced.
4. Check valve spring for free length, compressed length, distortion, or collapsed coils.

Assembly

1. Place diaphragm and valve assembly (8) on body, with valve seated in valve seat in body.
2. Install spring seat (4), spring (5), and dampener (7) in cover (3) and position cover on body (11).
3. Install four screws (9) through cover and diaphragm into body and tighten firmly.
4. Connect air supply line, with gauge, to valve inlet port, and adjust valve as previously directed under "Adjusting Set Pressure."

BRAKE APPLICATION VALVE (BENDIX-WESTINGHOUSE)

Brake application valve (fig. 17) is a treadle type brake valve mounted underneath the toeboard at the left side of coach. Brake treadle and roller assembly is mounted on top of toeboard.

OPERATION

1. Application

Foot pressure on brake treadle compresses graduating spring and forces piston down. This brings exhaust valve seat at lower end of piston to upper face of inlet-exhaust valve, closing exhaust passage. Continued downward movement of piston forces inlet valve off inlet valve seat. Air pressure from air tank then flows through inlet valve and outlet ports to brake chambers, applying service brakes.

2. Holding

The compensating passage in body permits air pressure being delivered to brakes to enter cavity below piston. When air pressure below piston balances treadle pressure, piston lifts far enough to

1 Treadle
2 Treadle Pin
3 Adjusting Screw
4 Mounting Plate
5 Body
6 Inlet Nut
7 Inlet Valve Guide
8 O-ring
9 Inlet and Exhaust Valve Assembly
10 O-ring
11 Piston Return Spring
12 O-ring
13 Piston
14 Filter Screen
15 Graduating Spring
16 Spring Seat
17 Adapter Plate
18 Boot
19 Plunger
20 Roller
21 Roller Pin

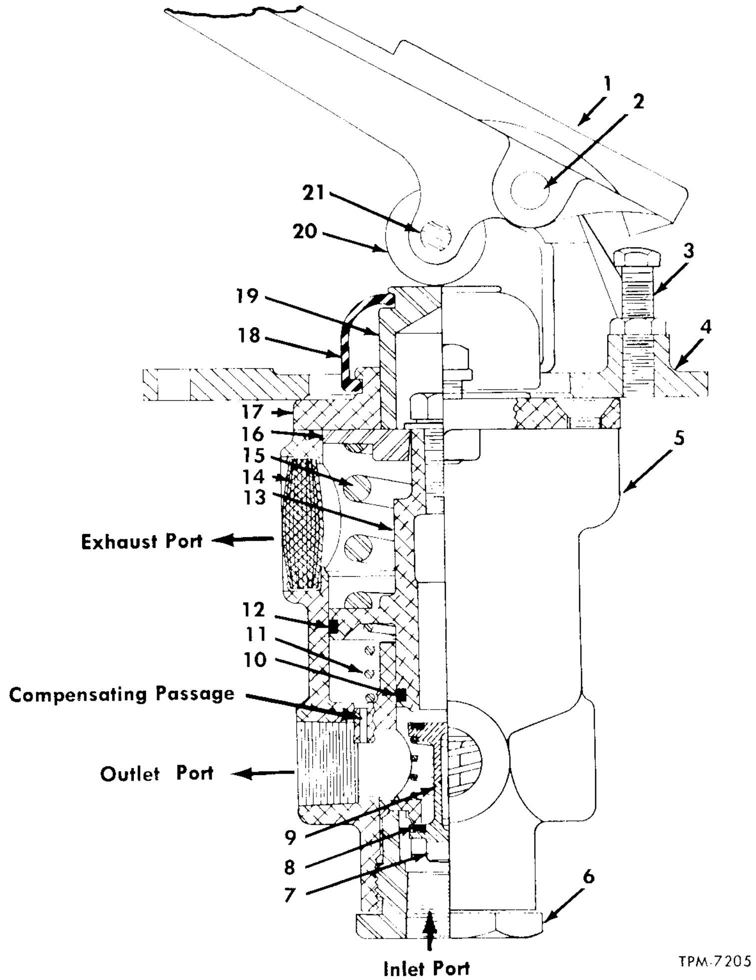


Figure 17—Brake Application Valve (Bendix-Westinghouse)

close inlet valve, cutting off further supply of air pressure to brake chambers. The exhaust valve remains closed preventing any escape of air pressure through exhaust port. Increased pressure on brake treadle forces piston down and causes a graduated increase of air pressure at brake chambers.

3. Partial Release

As pressure on brake treadle is reduced, spring and foot pressure above piston becomes less than air and spring pressure below piston, causing piston to move upward. As piston moves up, inlet valve closes and exhaust valve opens permitting air pressure below piston to escape through hollow center of piston and out exhaust port until pressure on each side of piston again balances.

4. Release

As foot pressure on brake treadle is removed, the exhaust valve opens and remains open, exhausting all air pressure from brake chambers through exhaust port and fully releasing service brakes.

APPLICATION VALVE SERVICEABILITY TESTS

1. Operating Tests

Check delivery pressure of the valve, using an accurate test gauge connected into one of the air lines leading to the brake chambers. With brake treadle fully depressed, test gauge should show the same pressure as registered on dash air gauge (within 5 pounds).

Depress brake treadle to several positions between fully released and fully applied and note that pressure registered by the test gauge varies in accordance with degree brake treadle is depressed.

2. Leakage Tests

a. With brake treadle fully released, coat ex-

haust port with soap suds to check for leakage. Leakage in excess of a 1-inch bubble in 1 second is not permissible. Leakage evidenced by this test is probably caused by worn or deteriorated inlet valve seat, preventing the piston from returning to fully released position.

b. With treadle fully depressed, coat exhaust port with soap suds to check for leakage. Leakage in excess of a 1-inch bubble in 1 second is not permissible. Leakage evidenced by this test may be due to a leaking exhaust valve or leaking piston O-ring seals.

APPLICATION VALVE REPLACEMENT

Removal

1. Exhaust air pressure from system.
2. Disconnect air lines at brake valve.
3. Remove three bolts, nuts, and washers attaching brake treadle mounting plate to floor. Remove valve assembly.

Installation

1. Place application valve assembly in position below floor. Attach to mounting plate with three bolts, nuts, and washers. Tighten securely.
2. Connect inlet line at bottom of valve. Connect outlet lines at side ports. Keep first two threads on air line fittings free from sealing compound. Tighten connections firmly. Replace pipe plugs in remaining ports.
3. Build up air pressure in system and test application valve as previously directed under "Serviceability Tests."

APPLICATION VALVE OVERHAUL

Key numbers in text refer to figure 17.

Disassembly

1. Clean all dirt from outside of valve.
2. Remove two cap screws and lock washers attaching mounting plate (4) to adapter plate (17). Separate treadle and valve.
3. Remove cotter pin, tap out treadle pin (2), and remove treadle (1) from mounting plate. Remove roller (20) by removing cotter pin and by tapping out roller pin with pin punch and small hammer. Remove roller. Both treadle pin and roller pin are held in place by cotter pins. Remove adjusting screw (3) and lock nut.
4. Remove boot (18) and plunger (19) from adapter plate (17). Remove three screws attaching adapter plate to body (5). Lift off adapter plate.
5. Lift piston and spring assembly from body. Remove O-rings (10 and 12) from piston and discard. Remove cap screw, lock washer, and flat washer from end of piston (13). Remove spring seat (16) and graduating spring (15) from piston.
6. Remove piston return spring (11) from body.
7. Remove inlet nut (6) and O-ring (8) from body. Discard O-ring. Remove inlet valve guide (7) and inlet and exhaust valve assembly (9) from body.
8. Remove self-tapping screw from body and take out filter screen (14). Remove pipe plugs.

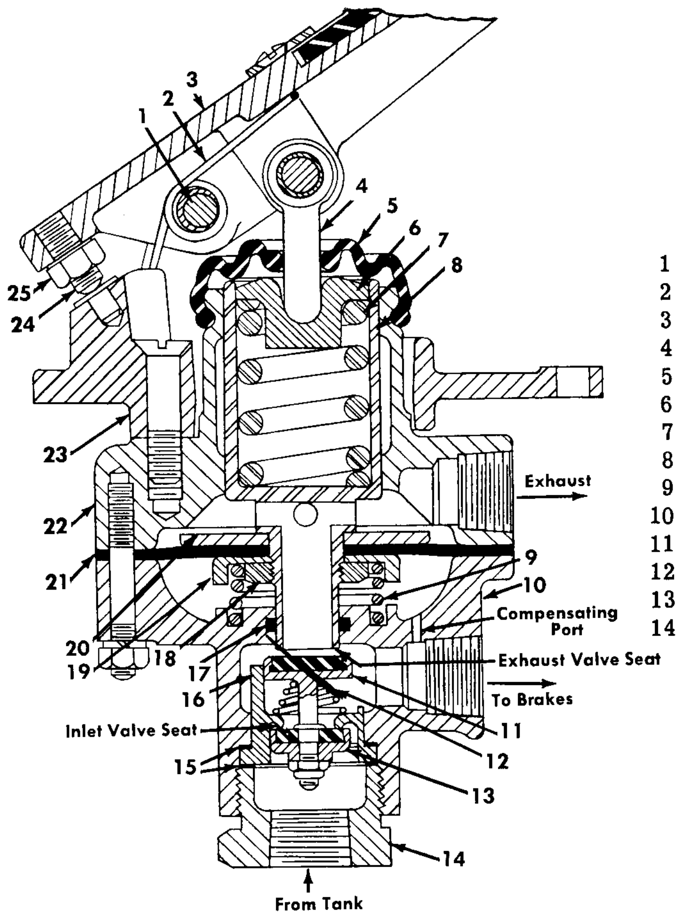
Inspection

Replace the following parts with new parts when overhauling application valve: Boot, O-rings, and inlet and exhaust valve assembly. Wash all other parts in cleaning solvent, dry thoroughly, and inspect as follows:

1. Treadle, Roller, and Pins. Check fit of treadle pin in treadle and mounting plate. Pin must be a neat, free fit. If mounting plate holes are worn excessively, the plate should be replaced. Check fit of roller on roller pin. There should be a free rolling fit between roller and pin. Replace badly worn or damaged parts with new parts.
2. Adapter and Plunger. Inspect adapter plate for cracks or signs of damage. Check fit of plunger in adapter plate. Replace parts if necessary.
3. Piston. Inspect exhaust seat of piston. Remove slightly worn spots by lapping on a piece of crocus cloth on a flat surface. Inspect outside surfaces of piston which contact bores in body of valve for scratches, nicks, or out-of-round condition. Replace piston if badly worn or damaged.
4. Piston Return Spring, Graduating Spring, and Seat. Inspect piston return spring, graduating spring, and spring seat. Damaged or broken spring or seat should be replaced with new part.
5. Inlet and Exhaust Valve Assembly. Inspect seating surface of inlet and exhaust valve for roughness or signs of wear that might cause leakage. Replace assembly if badly worn or damaged.
6. Body. Inspect bores of body for scratches, scores, or excessive wear. Remove any obstruction from compensating passage. Replace body if necessary.

Assembly (Fig. 17)

1. Install cleaned or new filter screen (14) in exhaust port of valve body (5). Install self-tapping screw to lock filter screen in place.
2. Place graduating spring (15) and spring seat (16) over piston. Install flat washer, lock washer, and cap screw at top of piston. Tighten cap screw firmly against spring retainer. Install new O-rings (10 and 12) on piston (13). Coat O-rings, piston, and piston bore with grease containing zinc oxide (#1). Install return spring (11) and piston assembly in body.
3. Install adapter plate (17) on body. Secure in place with three screws.
4. Install plunger (19) and boot (18) in adapter plate.



1 Treadle Pin
2 Treadle Spring
3 Treadle
4 Push Rod
5 Boot
6 Push Rod Cup
7 Piston Spring
8 Piston
9 Diaphragm Spring
10 Body
11 Exhaust Valve
12 Valve Cage Spring
13 Inlet Valve
14 End Cap
15 Gaskets
16 Valve Cage
17 O-ring
18 Diaphragm Nut
19 Diaphragm Nut Washer
20 Diaphragm Plate
21 Diaphragm
22 Valve Cover
23 Mounting Plate
24 Treadle Adjusting Screw
25 Screw Lock Nut

Figure 18—Brake Application Valve (Midland-Ross)

5. Install inlet and exhaust valve assembly (9) after positioning inlet valve guide (7) on the inlet valve seat. Place new O-ring (8) under inlet valve seat and install inlet nut (6).

6. Place roller (20) in position in treadle (1) and tap roller pin (21) in place. Install new cotter pin. Install adjusting screw (3) and lock nut on mounting plate.

7. Place treadle assembly in position on mounting plate and tap treadle pin (2) in place. Install new cotter pin.

8. Place treadle mounting plate on valve adapter plate, and attach with two cap screws and two lock washers.

BRAKE APPLICATION VALVE (MIDLAND-ROSS)

Brake application valve is a treadle operated compensating type valve mounted underneath driver's floorboard. Brake treadle is bolted on top of floorboard. The treadle push rod transfers movement of treadle to push rod cup.

OPERATION (Fig. 18)

1. Application

As brake treadle is pushed down, pressure is applied through push rod, push rod cup, and pressure regulating spring to piston and diaphragm. As piston and diaphragm move downward, the exhaust valve seat at bottom of the piston contacts exhaust valve seat. Continued downward movement of the piston and diaphragm pushes inlet valve off its seat. Air pressure from tank flows through the inlet valve and out ports to front and rear brakes.

The treadle stop screw on toeboard stops the treadle just below point at which full air pressure in system is delivered to brakes. Fully depressing the treadle without this stop could damage internal parts of valve assembly.

2. Holding

The compensating passage in body permits air being delivered to brakes to enter cavity below diaphragm. When air pressure below the diaphragm balances treadle pressure, diaphragm lifts far

enough to close inlet valve, but not far enough to open exhaust valve. No more air is admitted to brakes, and no air can exhaust from brakes. When treadle is pressed down further pushing down diaphragm, an equal amount of additional air pressure will be applied to brakes.

3. Partial Release

When brake treadle is partly released, air pressure lifts diaphragm, closing inlet valve and opening exhaust valve. Brake air escapes through hollow piston and through exhaust port. Compressed air from brakes will continue to exhaust until brake pressure balances with treadle pressure.

4. Release

When brake treadle is released, the diaphragm lifts and exhaust valve opens. Brake air escapes, releasing brakes.

APPLICATION VALVE SERVICEABILITY TESTS

1. Operating Tests

a. Check delivery pressure of the valve with an accurate test gauge. Disconnect flexible line from a front brake chamber. Connect test gauge to this flexible line. With the treadle pushed down against treadle stop screw, gauge reading should indicate full air system pressure. The stop screw should be adjusted to stop treadle just below full pressure point.

b. Push brake treadle to several test positions. Check gauge and make sure that brake pressure and treadle pressure follow closely.

2. Leakage Tests

a. With treadle fully released, coat exhaust port with soap suds and check for leakage. Bubbles are probably caused by a worn or deteriorated inlet valve seat. Binding or corrosion between piston and upper body can also prevent piston from returning to fully released position.

b. With treadle pressed down, coat exhaust port with soap suds and check for leakage. Leakage here may be caused by a worn or deteriorated exhaust valve seat or by a leaking diaphragm.

APPLICATION VALVE REPLACEMENT

Removal

Exhaust air from system and disconnect air lines from valve. Remove treadle hinge pin and remove treadle and spring. Remove mounting screws with screwdriver at top side of floorboard. Remove valve from under vehicle.

Installation

Position valve under the toeboard and install mounting screws. Position treadle spring and treadle and install treadle hinge pin. Adjust screws at base of treadle to remove all clearance between treadle push rod and push rod cup (fig. 18). Connect air lines; then start engine and build up air pressure in system. Test valve as previously described under "Serviceability Tests."

APPLICATION VALVE OVERHAUL

Key numbers in text refer to figure 18.

Disassembly

1. Clean all dirt from valve body before disassembling. Mark upper (22) and lower body (10) for proper assembly later.

2. Remove rubber boot (5) from upper body (22). Lift push rod cup (6) and piston spring (7) out of upper body.

3. Remove three nuts and three cap screws holding upper body to lower body. Separate bodies. Remove diaphragm (21) and piston (8) assembly from upper body. Remove diaphragm spring (9) from lower body (10).

4. Unscrew lower body end cap (14). Remove valve cage (16) and inlet (13) and exhaust valve (11) assembly. Remove and discard O-ring (17).

5. Hold exhaust valve (11) with pliers and remove lock nut attaching inlet valve (13) to exhaust valve stem (11). Remove inlet valve (13). Remove exhaust valve (11) and valve spring (12) from valve cage (16).

6. To disassemble the diaphragm (21) and piston (8), mount piston in vise. Use radius blocks or soft jaws to keep from crushing piston or marring piston surface. Remove diaphragm nut (18), diaphragm nut washer (19), diaphragm (21), and diaphragm plate (20) from piston (8).

Inspection

A repair kit is available which contains all parts ordinarily needing replacement at overhaul of the application valve. Install these new parts whenever valve is disassembled. The following parts are contained in kit: Intake and exhaust valve assembly, diaphragm, boot, gaskets, and O-ring. Discard old parts to be replaced. Inspect remaining parts as follows:

1. Thoroughly wash parts in a suitable cleaning solvent.

2. Inspect small and large radii of piston for nicks or corrosion. Inspect inside bore of upper body for scoring or corrosion. Corrosion or slight scratches may be removed with fine steel wool.

3. Examine inside surface of valve cage contacted by inlet and exhaust valves. Corroded surface could restrict movement of valves.

Assembly

1. Insert new O-ring (17) in piston bore of lower body.

2. Mount piston (8) in vise, small end up. Use radius blocks or soft jaws to prevent crushing or marring of piston. Install diaphragm plate (20) (bevelled edge to diaphragm), and diaphragm (21). Install diaphragm nut washer (19) with cup away from diaphragm (21). Coat piston threads with shellac and install diaphragm nut (18). Tighten nut firmly and stake in three places.

3. Place valve spring (12) over exhaust valve stem, small end next to valve. Insert valve stem (11) through valve cage (16). Install inlet valve (13) on valve stem with rubber seal next to seat. Hold exhaust valve (11) with pliers and install lock nut. Tighten nut firmly.

4. Install valve assembly in lower body (10). Use new gasket on both sides of valve cage flange (16). Install end cap (14).

5. Coat piston with grease containing zinc oxide (#1) and insert in upper body. Mount upper body (22) in vise, diaphragm (21) up. Align holes in diaphragm (21) with holes in body (10). Place diaphragm spring (9) in diaphragm nut washer. Install lower body (10), using marks made earlier. Make sure piston enters O-ring seal in body and that diaphragm spring (9) enters recess in body. Install three nuts and lock washers and three cap screws to hold bodies together. Tighten firmly.

6. Insert piston spring (7) in top of upper body (22). Install push rod cup (6) on top of spring; then install rubber boot (5).

REAR BRAKE RELAY VALVE (BENDIX-WESTINGHOUSE)

Key numbers in text refer to figure 19.

Relay valve is mounted on bulkhead above rear axle. Rear brake application and release is made through the relay valve. The supply line from air tank connects to a cavity in lower part of the valve, providing a source of high pressure air close to rear brake chambers at all times. The relay valve and brake application valve are interconnected by a smaller air line which delivers air pressure to top of the relay valve diaphragm to actuate the valve. In addition to providing more rapid application of rear brakes, relay valve also fulfills the function of a quick release valve, permitting rapid release of air pressure from rear brake chambers.

RELAY VALVE OPERATION (Fig. 19)

Operation of the relay valve is controlled by air pressure delivered to it by the brake application valve. Air pressure from brake application valve enters a cavity above the rubberized diaphragm. Since this cavity is comparatively small and therefore subject to quick changes in air pressure, action of the valve in changing its delivered pressures is very rapid.

1. Applying

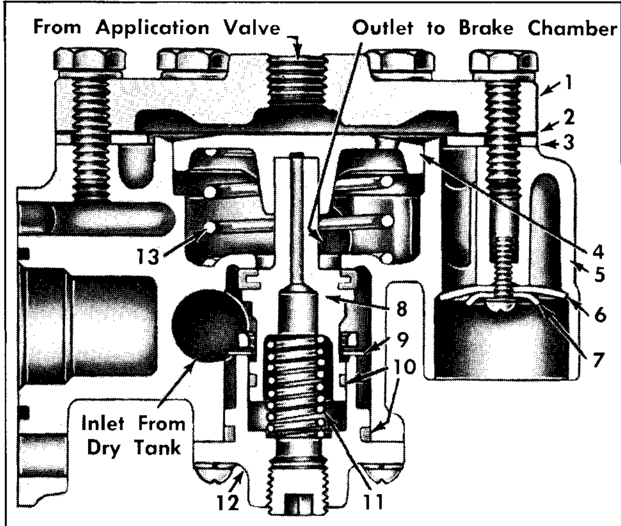
As compressed air from the application valve enters cavity at top, air pressure pushes down diaphragm sealing off exhaust cavity. Further movement of diaphragm center forces down diaphragm guide and inlet valve. As inlet valve is forced off seat, air from (dry) air tank flows through valve into cavity below diaphragm and on out to brake chambers.

2. Holding

As soon as air pressure above the diaphragm stops increasing, pressure below the diaphragm balances by means of the by-pass port in valve cover. This balance of pressures on each side of diaphragm removes pressure from diaphragm guide and inlet valve. Valve spring then closes inlet valve. Air pressure above the diaphragm maintains seal between outer edge of diaphragm and rim of exhaust cavity. The valve is now in holding position. Brake chamber pressure is the same as application valve pressure. An increase in pressure at application valve will immediately result in the same pressure increase in brake chambers.

3. Releasing

When the application valve pressure above diaphragm is reduced, brake chamber pressure (below diaphragm) forces diaphragm upward. As diaphragm uncovers rim of exhaust cavity, air is



1 Valve Cover	8 Inlet Valve
2 Valve Diaphragm	9 Retaining Ring
3 Diaphragm Ring	10 O-ring
4 Diaphragm Guide	11 Valve Spring
5 Body	12 Guide Cap
6 Exhaust Diaphragm	13 Spring
7 Diaphragm Washer	

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Figure 19—Rear Brake Relay Valve (Bendix-Westinghouse)

exhausted until pressures again balance. If all pressure is removed from application valve treadle, the relay valve will release all air from brake chambers fully releasing brakes.

RELAY VALVE SERVICEABILITY TESTS

1. Operating Test

With air brake system fully charged, apply brakes and make sure rear wheel brakes apply promptly. Release brakes and make sure air pressure is quickly exhausted from exhaust port of the relay valve.

2. Leakage Tests

a. With brakes released, cover exhaust port with soap suds. Leakage in excess of 1-inch bubble in one second is not permissible. Leakage is caused by inlet valve not seating properly.

b. With brakes applied, cover exhaust port with soap suds. Leakage in excess of a 1-inch bubble in one second is not permissible. Leakage is caused by defective diaphragm or seat.

c. If leakage is caused by diaphragm, both diaphragm and diaphragm seat should be wiped clean with gasoline. If leakage is caused by inlet valve, valve and seat must be cleaned, or replaced with new parts.

RELAY VALVE REPLACEMENT

Removal

1. Exhaust air pressure from system.
2. Disconnect air lines from valve.
3. Remove stop light wires.
4. Remove mounting bolts; then remove valve assembly from vehicle.
5. Remove stop light switch and tee fitting from top of valve.

Installation

1. Install tee fitting and stop light switch on top of valve.
2. Mount valve on frame and tighten mounting bolts firmly.
3. Connect air lines to valve, and wires to stop light switch.
4. Build up air pressure in system; then test valve as previously directed under "Serviceability Tests."

RELAY VALVE OVERHAUL

Disassembly (Fig. 19)

1. Mark valve cover (1), diaphragm ring (3), and valve body (5), so parts can be reassembled in same position.
2. Remove six cap screws and lock washers attaching valve cover (1) to valve body (5).
3. Remove cover (1), diaphragm (2), diaphragm ring (3), diaphragm guide spring (13), and diaphragm guide (4) from valve body (5).
4. Remove four screws and lock washers attaching guide cap (12) to bottom of valve body (5).
5. Remove valve cap (12) and inlet valve assembly (8).
6. Remove retaining ring (9) and separate inlet valve, valve spring (11), and guide cap (12). Remove and discard O-rings (10).
7. Remove screw and lock washer holding exhaust diaphragm (6) in place. Remove diaphragm washer (7) and exhaust diaphragm (6).

Inspection

1. Thoroughly clean all parts in a suitable cleaning solvent.
2. Examine diaphragms for cracking, stretching, or deterioration. Replace if not in good condition.
3. Inspect diaphragm seat at top of valve body. Seat must be smooth and free from scratches or corrosion. If only slightly scratched or corroded, seat may be repaired by lapping on a flat surface covered with fine aluminum oxide abrasive cloth.
4. Examine inlet valve and inlet valve seat. Rubber seating surface on inlet valve is bonded in place. If valve or seat are scratched or worn, replace with new parts.
5. Inspect springs for free length, compressed length, distortion, or collapsed coils.
6. Diaphragm guide bore in valve body, and inlet valve bore in guide cap should be smooth. If damaged, replace parts.

Relay Valve Assembly (Fig. 19)

1. Place new O-ring (10) on guide cap (12) and on inlet valve (8).
2. Apply thin coat of grease containing zinc oxide (#1) inside guide cap, and on body bores in contact with cap and with diaphragm guide (4).
3. Insert spring (11) and O-ring end of inlet valve (8) in guide cap (12) bore. Force inlet valve down into guide cap.
4. Place retaining ring (9) in cap groove and snap around narrow neck of inlet valve (8).
5. Insert inlet valve and cap assembly through bottom of relay valve body (5).
6. Attach cap to body with four screws and lock washers. Tighten firmly.
7. Position diaphragm guide spring (13) in valve body; then place diaphragm guide (4) over stem of inlet valve (8).
8. Position diaphragm ring (3), on body (5) aligning match marks previously installed.
9. Place diaphragm (2) on ring (3) and align by-pass holes.
10. Install cover (1) aligning match marks. Parts should be aligned now, without obstructing by-pass port.

11. Install six cap screws and lock washers and tighten firmly and evenly.

12. Insert exhaust diaphragm (6) and diaphragm washer (7) (cupped away from diaphragm) in exhaust port. Install screw and lock washer and tighten firmly.

REAR BRAKE RELAY VALVE (MIDLAND-ROSS)

Rear brake relay valve regulates air supply from a source close to rear brakes. Relay valve is operated by brake application valve. Valve is mounted on bulkhead above rear axle. Air supply line from air tank leads to cavity in lower part of valve. Control pressure line from application valve connects to top of relay valve.

RELAY VALVE OPERATION (Fig. 20)

1. Applying

As air from application valve enters cavity above diaphragm, pressure depresses diaphragm. Downward movement of diaphragm and plunger causes lower end of plunger to contact exhaust valve, closing exhaust port and forcing inlet valve off valve seat. Air will then flow from air supply cavity through valve into brake chambers and apply rear brakes.

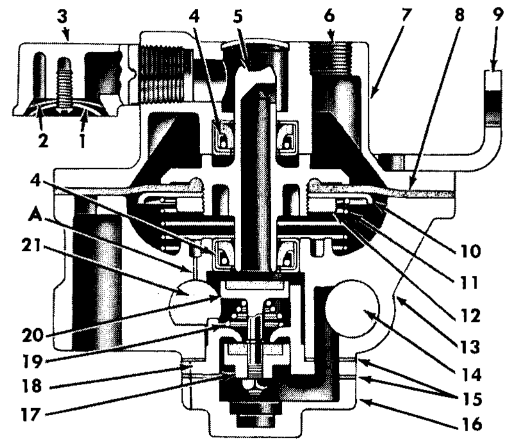
2. Holding

The by-pass port (passage A, fig. 20) permits air being delivered to rear brake chambers to enter cavity below diaphragm. When combined forces of air pressure and plunger return spring pressure below diaphragm balances air pressure on top of diaphragm and plunger, plunger is forced upward. This permits inlet valve to close, but not enough to open exhaust valve. Pressure build-up stops, and at the same time air already delivered to rear brakes is prevented from escaping through exhaust port. Relay valve in holding position now maintains same pressure in brake chambers as application valve is delivering.

When brake treadle is depressed still further, admitting more air to top of diaphragm and plunger, there is a corresponding increase in air pressure at rear brakes. Upon partial release of treadle, air pressure below diaphragm overcomes reduced pressure above. Plunger is then forced upward and air from rear brake chambers is exhausted until pressure below diaphragm balances the pressure above.

3. Release

When brake treadle is returned to fully released position, application valve exhausts air



1 Check Valve Guard
2 Exhaust Check Valve
3 Check Valve Body
4 Plunger Seals
5 Plunger
6 Actuating Air Line Port
7 Upper Body
8 Diaphragm
9 Mounting Bracket
10 Diaphragm Plate
11 Diaphragm Spring
12 Diaphragm Nut
13 Lower Body
14 Air Supply Cavity
15 Gaskets
16 Inlet Valve Cover
17 Inlet Valve
18 Valve Cage
19 Valve Spring
20 Exhaust Valve
21 Service Line Port

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Figure 20—Rear Brake Relay Valve (Midland-Ross)

from cavity above diaphragm and plunger. Pressure below diaphragm then lifts diaphragm and plunger, permitting inlet valve to close and exhaust valve to open. Air in brake chambers then passes through exhaust valve and hollow plunger into exhaust cavity and out exhaust port to atmosphere.

RELAY VALVE SERVICEABILITY TESTS

1. Operating Test

With air brake system fully charged, apply brakes and see if rear brakes apply promptly. Release brakes and make sure air is quickly exhausted from the exhaust port of the relay valve.

2. Leakage Test

a. With air system fully charged, coat relay valve exhaust port with soap suds to check for leaks. Leakage in excess of a one-inch bubble in three seconds is not permissible. Bubbles are probably caused by dirt on inlet valve, or a damaged inlet valve or seat.

b. With brakes fully applied, coat relay valve exhaust port with soap suds to check for leaks. Leakage in excess of a one-inch bubble in three seconds is not permissible. Bubbles are probably caused by dirt on exhaust valve, by a damaged exhaust valve, or by damaged seat at bottom of plunger.

RELAY VALVE REPLACEMENT

Removal

1. Exhaust air pressure from the system.
2. Disconnect air lines from valve.
3. Remove stop light wires and mounting bolts. Remove relay valve assembly.

Installation

1. Position relay valve on coach bulkhead; then install attaching bolts. Tighten bolts firmly.
2. Reconnect stop light wires and air lines.
3. Build up air pressure in air system as previously directed under "Serviceability Tests."

RELAY VALVE OVERHAUL

Disassembly (Fig. 20)

1. Unscrew check valve body (3) from exhaust port in upper body (7). Remove screw attaching exhaust check valve (2) and guard (1) to valve body. Remove valve and guard.
2. Mark mounting bracket (9), upper body (7), and lower body (13) in some manner to identify their relative positions for reassembly. Remove six bolts attaching upper body to lower body; four of these bolts also attach the mounting bracket. Remove bracket and upper body from lower body.
3. Remove diaphragm and plunger assembly (5 and 8) and diaphragm spring (11) from lower body.
4. Remove nuts from four studs securing inlet valve cover (16) to lower body and remove cover. Remove valve cage (18) and inlet and exhaust valve assembly (17 and 20), and gaskets (15) from lower body.
5. Hold exhaust valve (20) with pliers and remove nut securing inlet valve (17) on exhaust valve stem. Remove inlet valve from exhaust valve stem, then remove exhaust valve from valve cage.
6. To disassemble diaphragm and plunger, hold plunger (5) and remove diaphragm nut (12), diaphragm plate (10), and diaphragm from plunger. Hold plunger in such a manner that surfaces which contact oil seals will not be damaged.
7. Remove plunger seals (4) from upper and lower bodies.

Cleaning (Fig. 20)

Always replace the following parts with new parts when overhauling the relay valve: Exhaust check valve (2), plunger seals (4), diaphragm (8), gaskets (15), inlet valve (17), and exhaust valve (20). All other parts may be reused if no cracks or other damage is evident. Wash parts in cleaning solvent and dry thoroughly. Make sure passage "A" in lower body (13) is not obstructed.

Assembly (Fig. 20)

1. Install new plunger seals (4) in upper and lower bodies (7 and 13), with seal lips in direction shown in figure 20.
2. Install diaphragm (8) on lower end of plunger (5). Be sure bead around hole in diaphragm (8) is seated in groove in plunger (5). Place diaphragm plate (10) on plunger with cupped side away from diaphragm. Coat threads on plunger with shellac, and install diaphragm nut (12). Hold plunger, using care not to damage ends which contact seals, and firmly tighten diaphragm nut.
3. Place valve spring (19) over exhaust valve stem with small end next to exhaust valve (20). Insert valve stem through valve cage (18). Place inlet valve (17) on valve stem with insert facing seat in valve cage. Coat valve stem threads with shellac (do not get shellac on valve inserts), install nut on valve stem, and tighten firmly.
4. Install valve and cage assembly in lower body, using new gasket (15) on both sides of cage flange. Install inlet valve cover and secure with four stud nuts and lock washers. Tighten nuts firmly.
5. Place diaphragm spring (11) in lower body. Coat both ends of plunger with grease containing zinc oxide (#1); then install diaphragm and plunger assembly on lower body with lower end of plunger inserted through seal in body. Align holes in diaphragm with holes in lower body.
6. Place upper body (7) on lower body with upper end of plunger inserted through seal in upper body. Align marks made on upper and lower bodies before disassembling.
7. Place mounting bracket (9) on upper body, with marks aligned. Install six bolts attaching upper and lower bodies and mounting bracket together, using the four longest bolts through the mounting bracket. Install lock washer and nut on each bolt and tighten evenly and firmly.
8. Install exhaust check valve (2) and guard (1) in check valve body (3) and secure with screw. Thread check valve body into exhaust opening in upper body, leaving exhaust opening pointing down when fully tightened.

FRONT BRAKE LIMITING VALVE AND TWO-WAY CONTROL VALVE

A combination limiting and quick-release valve (fig. 22) and a two-way control valve (fig. 23) are used in combination on some vehicles as shown in figure 21. This combination delivers full air pressure to front brakes when on dry roads, or at the option of the driver, limits front brake air pressure by half when on slippery roads.

The two-way control valve is mounted at right side of seat within easy reach of the driver. The limiting quick-release valve is mounted beneath coach floor near front axle. One air line from brake application valve is connected to the inlet

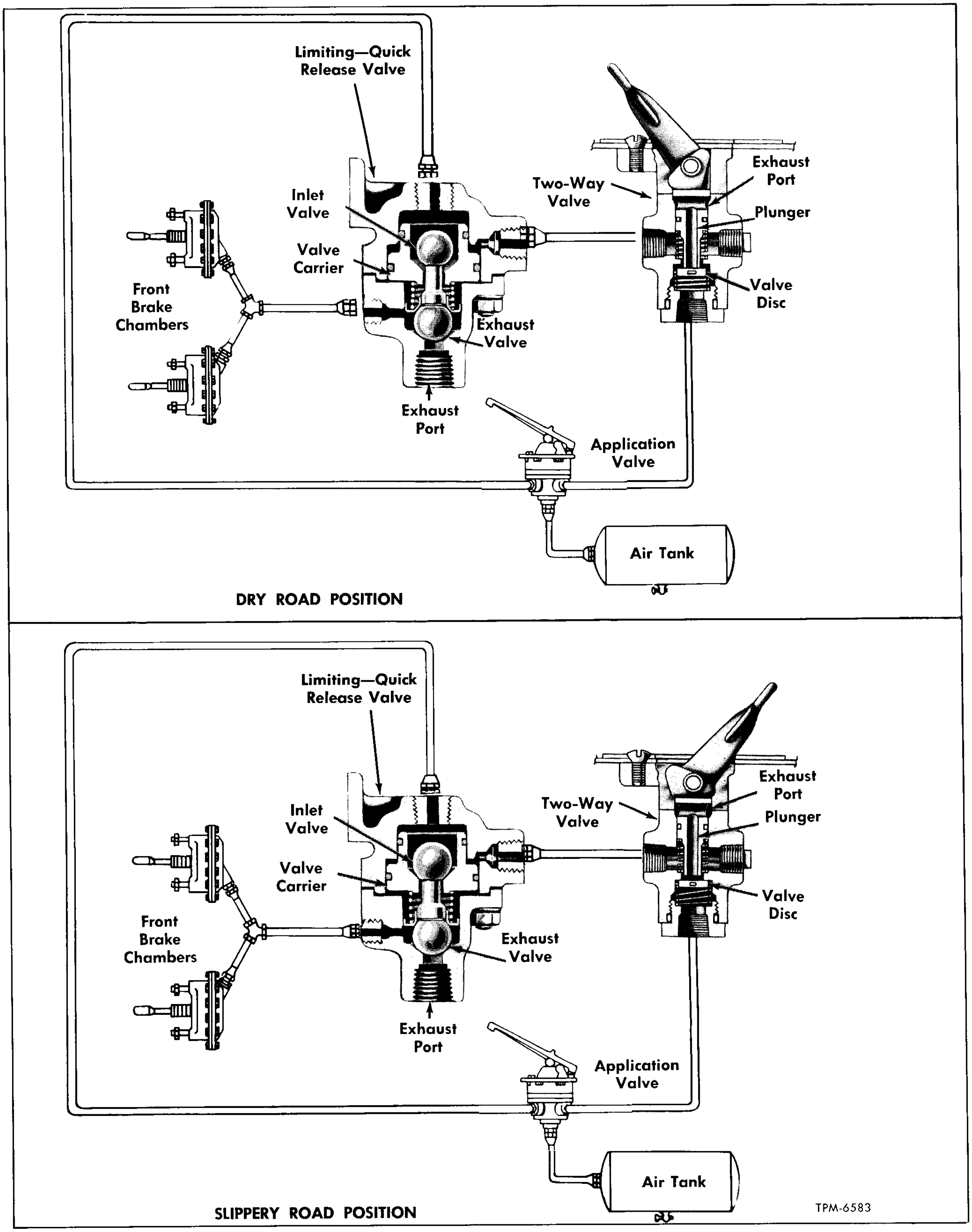


Figure 21—Front Brake Limiting and Two-Way Control Valve Operation

port of the two-way valve and another line connects to the brake valve port at top of limiting quick release valve (fig. 21). Another air line connects side delivery port of the control valve to port opposite the mounting pad of the limiting valve. The two other side ports of the limiting valve are connected to front brake chambers.

OPERATION

1. Dry Roads (Top View, Fig. 21)

a. When handle of the two-way valve is placed in "DRY ROAD" position, the hollow plunger of the valve is depressed and contacts the valve disc, unseating the valve. In this position, air passage through the hollow plunger is closed and air pressure from application valve has free passage through the two-way valve to front port of the limiting quick release valve.

b. When coach brakes are applied, air pressure from the brake application valve enters limiting quick release valve at the top. This air pressure, acting on upper inner surface of the valve carrier, forces carrier down until the exhaust valve contacts valve seat in the valve cover, closing the exhaust port. The carrier still continues to move downward, partially opening the inlet valve.

c. At the same time, pressure from the application valve passes through the two-way valve as explained in (a) above, and enters limiting quick release valve at the side. With the valve carrier already partially depressed, air pressure coming from the two-way valve acts on larger outer surface of the valve carrier and forces the carrier down still further to limit of travel. This action moves the carrier fully away from the inlet valve, permitting full application valve pressure to be delivered to the front brake chambers.

2. Slippery Roads (Bottom View, Fig. 21)

a. When handle of the two-way valve is placed in "SLIPPERY ROAD" position, the hollow plunger is raised by the plunger spring and valve disc is held closed by the valve spring. Any air pressure in line connecting the limiting quick release valve and the two-way valve will be exhausted through the hollow plunger and exhaust port of the two-way valve.

b. When the brake application valve is applied with the two-way valve in slippery road position, air pressure from brake application valve is stopped at the valve disc of the two-way valve and does not enter the side port of limiting quick release valve. At the same time, however, air pressure from the application valve enters limiting quick release valve at top. This pressure, acting on upper inner surface of the valve carrier, forces carrier down until exhaust valve closes the exhaust port and partically opens the inlet valve. Air pressure passing by the inlet valve and building up in brake chambers is acting on the lower surface of valve carrier. The lower surface of valve carrier is approximately twice as large as the upper inner surface. Therefore, when pressure acting on the lower surface of the carrier is approximately one-half application valve delivery pressure, the valve carrier moves up and closes the inlet valve, and the exhaust valve will remain closed. The limiting quick release valve is then in a position where pressure in the lower portion of the valve and in brake chambers will be approximately one-half pressure being delivered to upper portion of the valve by the application valve.

SERVICEABILITY TESTS

1. Operating Tests

a. Install an air pressure test gauge in application valve delivery line. A convenient method of connecting gauge is to remove stop light switch at front of application valve and connect gauge to stop light switch fitting. Disconnect one front brake chamber line from port at side of limiting quick release valve and connect another test gauge to this port.

b. Place handle of the two-way valve in "DRY ROAD" position and apply brakes. Both test gauges should read the same. Place handle of the two-way valve in "SLIPPERY ROAD" position and apply brakes. The test gauge at the limiting quick release valve should read approximately one-half amount shown on the test gauge connected to the application valve delivery line.

2. Leakage Tests

a. Place handle of the two-way valve in "DRY ROAD" position and with brakes applied, coat exhaust ports of the two-way valve and limiting quick release valve with soap suds. Leakage at either port should not exceed a one-inch soap bubble in one second.

b. Place handle of the two-way valve in "SLIPPERY ROAD" position and with brakes applied, coat exhaust port of the two-way valve with soap suds. Leakage should not exceed a one-inch bubble in one second.

LIMITING AND QUICK RELEASE VALVE REPLACEMENT

Removal

1. Exhaust air pressure from the air system.

2. Disconnect all air lines from valve. Remove valve attaching screws and remove valve from support.

Installation

1. Position valve on support and install attaching screws. Tighten securely.

2. Connect air lines to valve, making sure all connections are tight.

3. Build up air pressure in system to normal operating pressure; then test valve as previously described under "Serviceability Tests."

TWO-WAY CONTROL VALVE REPLACEMENT

Removal

1. Exhaust air pressure from the air system.

2. Disconnect all air lines from control valve; then remove control valve from front of dash by removing two screws and valve dial.

Installation

1. Install control valve at front of dash panel attaching with valve dial and two screws.

2. Connect all air lines to valve, making sure all connections are tight.

3. Build up air pressure in system to normal operating pressure; then test valve as previously described under "Serviceability Tests."

LIMITING AND QUICK RELEASE VALVE OVERHAUL (Fig. 22)

Disassembly

1. Remove nuts and lock washers from studs securing valve cover to valve body. Separate cover and body. Remove and discard O-ring seal.

2. Push valve piston with inlet and exhaust valve assembly out of valve body.

3. Remove O-rings from grooves in valve piston. Discard O-ring seals.

Cleaning, Inspection, and Repair

1. Wash all metal parts in cleaning solvent. Wipe or blow parts dry.

2. Examine body and cover for cracks or other damage.

3. Inspect exhaust valve seat in cover; if seat is nicked, chipped, or worn, replace cover. Remove slight scratches or scores from inner surface of body with crocus cloth.

4. If any part of the valve piston or inlet and exhaust valve assembly is scratched, nicked, chipped, worn, or damaged in any way, the complete assembly must be replaced.

Assembly

1. Install new O-ring seals in grooves in valve piston; then place valve assembly in body.

2. Place new O-ring seal in cover, then install cover on body, making sure valve guide enters bore in cover. Install nuts and lock washers on cover-to-body studs and tighten firmly.

3. After installing valve in vehicle, or using a test hook-up, test valve as previously directed under "Serviceability Tests."

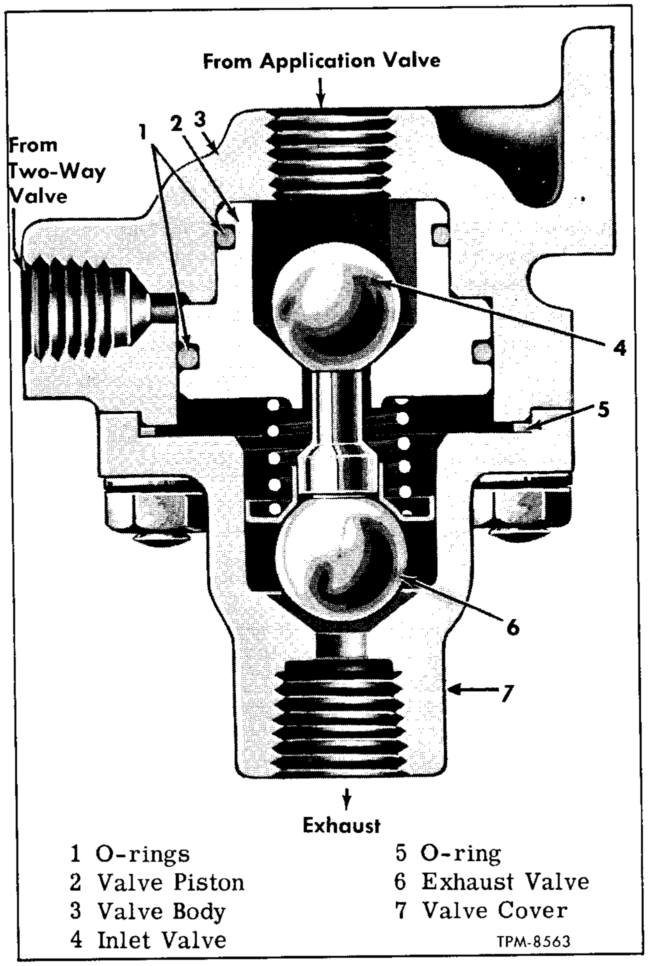


Figure 22—Front Brake Limiting and Quick Release Valve

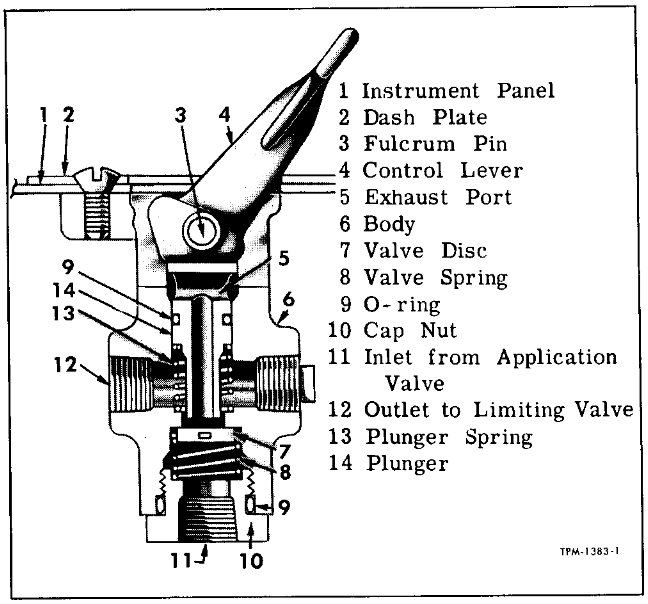


Figure 23—Two-Way Control Valve (Also I.C.C. Valve)

TWO-WAY CONTROL VALVE OVERHAUL (Fig. 23)

Disassembly

1. Using a small drift, drive out fulcrum pin securing control lever in valve body and remove lever.
2. Remove cap nut, O-ring, valve spring, and valve from bottom of body. Discard O-ring.
3. Push against bottom of valve plunger to remove plunger from top of body. Remove plunger return spring from body. Remove O-ring from plunger and discard.

Cleaning and Inspection

1. Wash all metal parts in cleaning solvent. Wipe or blow parts dry.
2. Carefully examine small end of plunger which contacts valve; if any roughness or damage is evident, replace plunger.
3. Inspect valve seat in body; if seat shows signs of wear or damage, replace body.
4. Replace valve disc if any wear or damage is evident. Replace valve spring if weakened by corrosion.

Assembly

1. Install new O-ring seal in groove of plunger and on cap nut.
2. Coat plunger, pin, and cam with grease containing zinc oxide (#1).
3. Place spring on small end of plunger, and install plunger and spring in top of body.
4. Install control lever in body, and secure with fulcrum pin. Stake pin in place.
5. Turn body bottom side up and install valve disc, valve spring, and cap nut, being sure new O-ring is in place on cap nut. Tighten cap nut firmly.
6. After installing valve in vehicle, or using a test hook-up, test valve as previously directed under "Serviceability Tests."

AUXILIARY BRAKE CONTROL (I.C.C.) BRAKE VALVE

OPERATION

I.C.C. (Interstate Commerce Commission) brake valve, along with an air pressure cut-off valve and a double check valve (fig. 24) are installed as special equipment on some vehicles. The I.C.C. valve is provided as an emergency method for applying the air brakes on rear axle. Valve is mounted at right side of driver. Valve control lever should remain in "OFF" position at all times during normal operation. When lever is moved to "ON" position, full air pressure in system is applied to brakes on rear axle only.

IMPORTANT: Valve should be tested at regular intervals to make sure it is operating properly.

THE I.C.C. valve and the two-way control valve

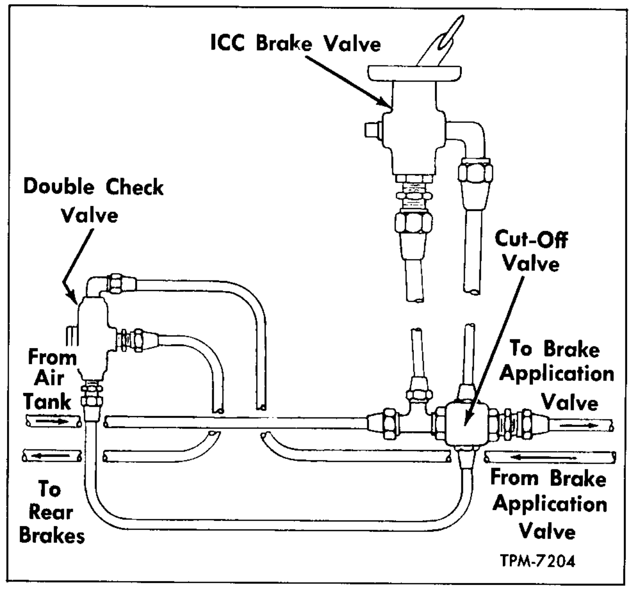


Figure 24—Auxiliary Brake Control Installation

shown in figure 23 are identical except for wording on dials. The following key numbers refer to figure 23. Valve is in "OFF" position, with plunger (14) raised and valve disc (7) against valve seat in body. Air supply line from front air tank is connected to inlet port (11) in cap nut (10). Outlet line to rear brake relay valve is connected to outlet port (12).

When control lever (4) is moved to "ON" position, cam on lever forces plunger down. Lower end of plunger seats against valve disc (7) closing exhaust passage through plunger, and forcing valve disc off seat in body. This permits full air pressure to flow past valve disc into line leading to rear brake relay valve. With full air pressure applied to relay valve, relay valve delivers full pressure to brakes on rear axle. At the same time, air pressure being delivered to relay valve enters top of air pressure cut-off valve, cutting off flow of air pressure to brake application valve and auxiliary air system. Refer to "Air Pressure Cut-off Valve" later.

When valve control lever is returned to "OFF" position, plunger spring raises plunger, permitting valve spring to seat valve disc against seat in body, shutting off flow of air pressure. Air pressure which has been let into line leading to relay valve is exhausted through the hollow plunger, permitting relay valve to exhaust air pressure from rear brakes.

I.C.C. BRAKE VALVE REPLACEMENT

Removal

1. Exhaust air pressure from air brake system.

2. Disconnect air lines from valve ports.
3. Remove two screws attaching valve to support. Remove valve assembly and dial.

Installation

1. Position valve assembly on support. Install dial and two screws. Tighten screws firmly.
2. Connect air lines to valve, making sure all connections are tight.
3. Build up air pressure in system to normal operating pressure.

NOTE: Refer to "Two-Way Valve Overhaul" earlier in this section for information on disassembly, inspection, and assembly of the I.C.C. valve. Procedures are the same.

AIR PRESSURE CUT-OFF VALVE

Air pressure cut-off valve (fig. 25) is installed in air line from front air tank supplying air pressure to brake application valve and auxiliary air system, and is also connected to the outlet side of the I.C.C. brake valve. Normally, air pressure from air tank lifts diaphragm in cut-off valve and flows through valve to brake application valve and auxiliary air system. When I.C.C. brake valve control lever is moved to "ON" position, air pressure from I.C.C. brake valve, flowing to rear brake relay valve, at the same time enters cut-off valve above the diaphragm. Combined force of air pressure and spring above diaphragm overcomes force of air pressure below diaphragm and forces diaphragm down, cutting off flow of air pressure to application valve and auxiliary air system.

Air cut-off valve is located at right of brake application valve. Arrows on top of valve body indicate normal direction of air flow through valve.

AIR PRESSURE CUT-OFF VALVE REPLACEMENT

Removal

1. Exhaust air pressure from the air system.
2. Disconnect all air lines from valve and remove valve.

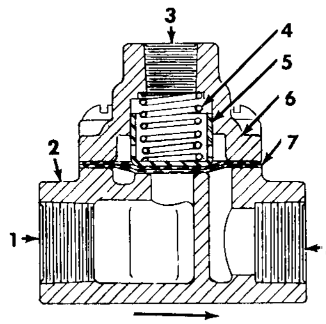
Installation

1. Connect all air lines to the valve, making sure all connections are tight. Be sure arrows on top of valve cover are pointed toward brake application valve.
2. Build up air pressure in the system to normal operating pressure.

AIR PRESSURE CUT-OFF VALVE OVERHAUL

Disassembly (Fig. 25)

Remove four screws attaching cover to body. Remove cover, spring, spring seat, and diaphragms.



1 From Air Tank
2 Body
3 From I.C.C. Valve
4 Spring
5 Spring Seat
6 Cover
7 Diaphragms
8 To Application Valve and Auxiliary Air System

TPM-2241

Figure 25—Air Pressure Cut-off Valve

Cleaning and Inspection (Fig. 25)

Clean all parts thoroughly. Examine diaphragms; if any signs of cracking or deterioration are evident, replace with new diaphragms. Make sure diaphragm seat in body is clean and smooth. Bore in cover must be clean and smooth to permit free movement of spring seat. If spring has been weakened by rust or corrosion, replace with new spring.

Assembly (Fig. 25)

Lubricate bore in cover contacted by spring seat with thin coat of grease containing zinc oxide (#1). Place diaphragms on body. Place spring and spring seat in cover and position cover on diaphragms and body. Install four screws and tighten securely.

DOUBLE CHECK VALVE

Double check valve (fig. 26) is installed in air line between I.C.C. valve and brake application valve. Valve is located near auxiliary or air suspension air tank. Lines from check valve lead to application valve, to I.C.C. valve, and to rear brake

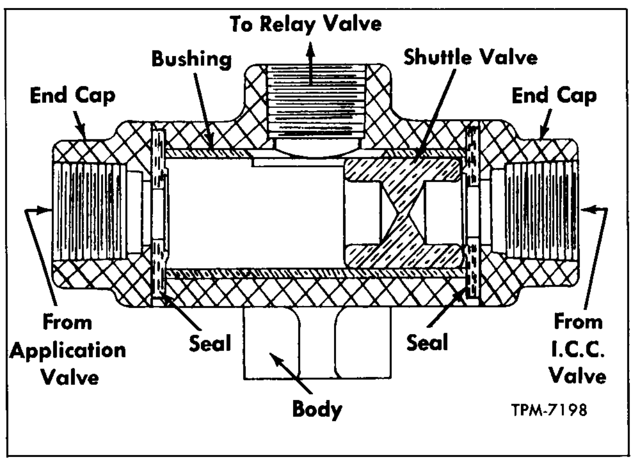


Figure 26—Double Check Valve

relay valve.

When I.C.C. brake valve lever is placed in "ON" position, compressed air from dry tank passes through I.C.C. valve and enters double check valve. The air pressure forces shuttle valve against inlet port from application valve. Air passes on through outlet port into rear brake relay valve and applies rear brakes only.

When I.C.C. brake valve lever is in "OFF" position and foot brake is applied, air pressure forces shuttle valve against inlet port. Compressed air then flows through outlet port to rear brake relay valve and applies rear brakes. Air from application valve also applies front brakes.

DOUBLE CHECK VALVE REPLACEMENT

Removal

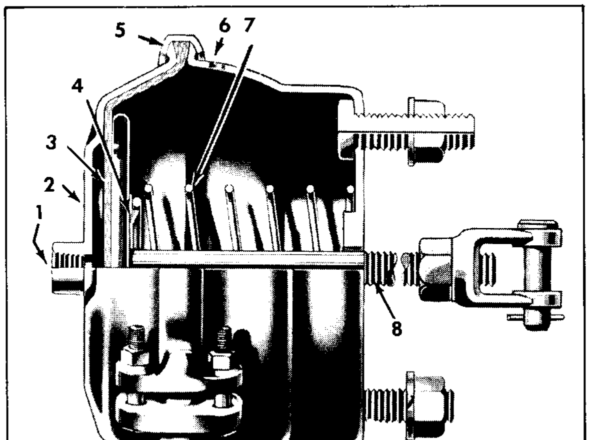
1. Exhaust air pressure from the air system.

2. Remove nuts and washers attaching check valve to mounting stud.

3. Disconnect all air lines from the valve and remove valve.

Installation

1. Mount check valve assembly on mounting stud and install nuts and washers. Tighten nuts firmly.
2. Connect all air lines to the valve ports, making sure all connections are tight.
3. Build up air pressure in the system to normal operating pressure.



1 Air Inlet Port
2 Pressure Plate
3 Diaphragm
4 Spring Guide
5 Clamping Ring
6 Non-Pressure Plate
7 Return Spring
8 Push Rod
TPM-9519

Figure 27—Brake Chamber (Typical)

DOUBLE CHECK VALVE OVERHAUL

Disassembly

1. Remove two cap screws, lock washers, and plain washers attaching valve cover to body. Separate cover from body.
2. Remove shuttle valve and valve guide from valve body.
3. Remove grommet from valve cap. Discard grommet.

Cleaning and Inspection

1. Clean parts in cleaning solvent. Wipe or blow parts dry.
2. Inspect parts for corrosion, wear, or other damage. Replace damaged parts.
3. Check shuttle valve. Valve should slide freely in guide.

Assembly

1. Install shuttle valve and guide in valve body.
2. Position a new grommet on valve cover.
3. Place cover on body and install two cap screws, lock washers, and plain washers. Tighten screws firmly.

AIR LINE FILLER VALVE

An air line filler valve installed in air line on engine compartment bulkhead (figs. 1 and 2), is used primarily to keep the air suspension system inflated during long periods while coach is standing idle. However, valve can be used to check air system pressure, by using an ordinary tire gauge.

BRAKE CHAMBERS

An air brake chamber (fig. 27) is used at each wheel to convert the energy of compressed air into the mechanical force and motion required to apply the brakes. The yoke on the brake chamber push rod connects to a slack adjuster which is mounted on the brake camshaft. Push rod opening and four equally spaced holes near clamping flange in non-pressure plate provide for breathing and drainage. Front brake chambers are connected to air system through the application valve. Rear brake chambers are connected through rear brake relay valve.

BRAKE CHAMBER OPERATION

As air pressure enters the brake chamber behind the diaphragm, the diaphragm forces push rod outward, thus applying force to the slack adjuster which rotates brake camshaft, applying brakes. When air pressure is released from the brake chamber, the brake shoe return springs and the push rod spring return brake shoes, camshaft, slack adjuster, push rod, and diaphragm to released position.

SERVICEABILITY TESTS

1. Operating Test

Apply brakes. Brake chamber push rods should move out promptly without binding. Release brakes. Rods should return to released position promptly without binding.

2. Leakage Tests

a. Fully apply brakes. Coat edges of the clamping ring with soap suds to check for leakage. No leakage is permissible. If leakage is found, tighten clamp ring bolts.

b. Fully apply brakes. Check for leakage through the diaphragm by applying soap suds to breather holes and to push rod hole. No leakage is permissible. If soap bubbles indicate a leak, replace diaphragm.

BRAKE CHAMBER REPLACEMENT

Removal

1. Disconnect hose from brake chamber as follows: Hold hose union nut with wrench while turning connector out of fitting or elbow in brake chamber. If new brake chamber is to be installed, remove connector fitting or elbow for installation on replacement unit.

2. Disconnect push rod yoke from slack adjuster.

3. Remove nuts and lock washers from mounting studs; then remove brake chamber assembly from bracket.

Installation

1. Position brake chamber at bracket, with mounting studs through holes in bracket. Install lock washer and nut on each stud and tighten firmly.

2. Install elbow or connector fitting in brake chamber.

3. Connect hose as follows: Thread connector into elbow or fitting and tighten firmly while holding hose union nut with wrench.

4. Connect brake chamber push rod yoke to slack adjuster. Adjust brakes as previously directed under "Brake Adjustments." Apply brakes and make sure push rods are correct length. Angle formed by push rod and slack adjuster should form an angle of more than 90 degrees, and should still be slightly greater than 90 degrees with brakes applied. In other words, the slack adjuster should not go "over center" when brakes are applied. If necessary, adjust push rod length by turning yoke on or off push rod. Push rod must not extend through yoke far enough to interfere with slack adjuster. Test brake chamber as previously directed under "Serviceability Tests."

BRAKE CHAMBER OVERHAUL

Disassembly (Fig. 27)

1. Before disassembling brake chamber, mark non-pressure plate, pressure plate, and clamp ring. Parts may then be reassembled in same position as before disassembly.

2. Remove yoke and lock nut from push rod. Remove nuts from two clamp ring bolts and remove bolts. Use caution when separating plates because of tension on return spring. Spread clamp ring and remove from plates; then remove pressure plate and diaphragm.

3. Remove push rod and spring from non-pressure plate.

Cleaning and Inspection

1. Clean all metal parts thoroughly, using a suitable cleaning solvent.

2. Examine diaphragm. Replace with new part if any signs of damage or deterioration are evident. Diaphragms should be replaced every 50,000 miles, or at least once a year.

3. Examine push rod and spring. Replace with new parts if not in first class condition. Replacement spring should have the same tension as spring in opposite brake chamber. Mismatched springs will result in unbalanced braking.

4. Inspect pressure plate and non-pressure plate. Clamping flanges on plates should not be bent or otherwise damaged. Replace damaged parts.

Assembly (Fig. 27)

1. Install spring and non-pressure plate on push-rod.

2. Place clamp ring over flange of non-pressure plate and align marks.

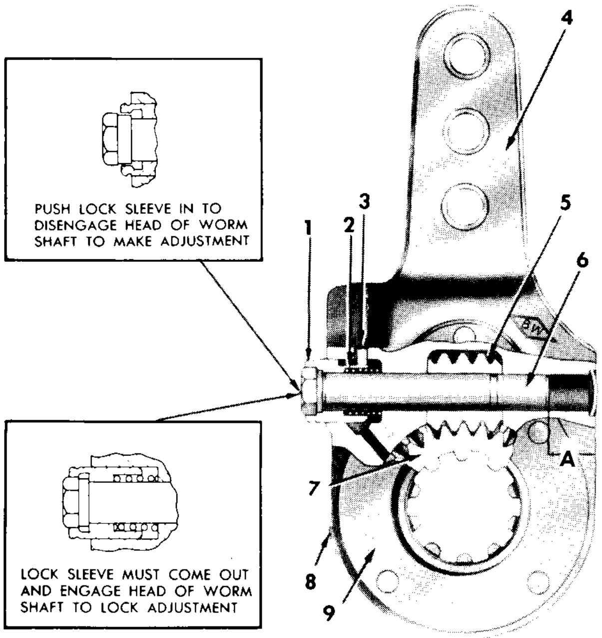
3. Position diaphragm in pressure plate. Position plate and diaphragm against the non-pressure plate; then place brake chamber assembly in a vise. Carefully close vise until clamp ring can be worked over flange of pressure plate. Align marks previously inscribed.

4. Use vise-grip pliers or C-clamp on side of lugs on clamp ring. Draw clamp ring together and install one bolt and nut. Remove tool and install the other bolt and nut. Tighten just enough to form an air-tight seal. Remove brake chamber from vise.

5. Install lock nut and yoke on push rod.

SLACK ADJUSTERS

Slack adjusters function as adjustable levers and provide a quick and easy method of adjusting the brakes to compensate for normal lining wear. Positive locking type slack adjusters are used at front and rear brakes. Construction of both front and rear slack adjusters is shown in figure 28.



1 Lock Sleeve
2 Spring
3 Dowel
4 Lever
5 Worm
6 Worm Shaft
7 Gear
8 Lubrication Fitting
9 Cover Plate

A—See Text TP 5521

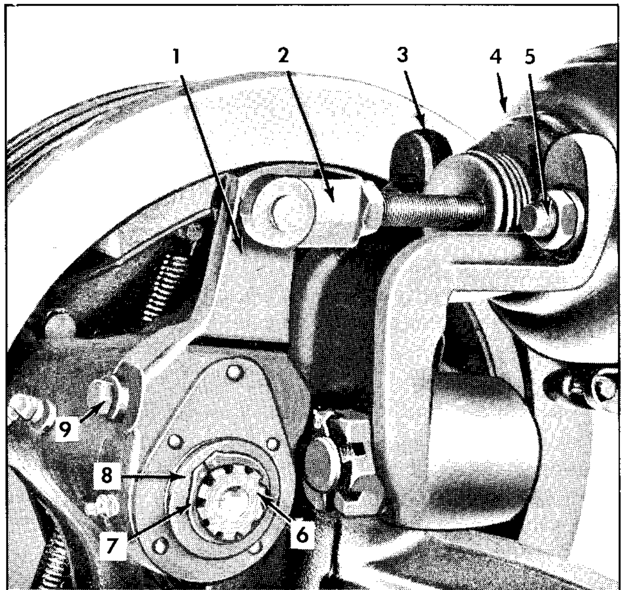
Figure 28—Slack Adjusters (Typical)

Front and rear slack adjuster installations are shown in figures 29 and 30.

Slack adjuster consists basically of a hardened steel gear which is splined to the brake camshaft, a brake lever (body), and a hardened steel worm. Worm is mounted in the lever above the gear and meshes with the teeth in the gear. Turning the worm shaft causes rotation of the camshaft in relation to the brake lever. During brake operation, the entire slack adjuster rotates bodily with the camshaft. As the brake chamber push rod reaches its maximum travel due to normal lining wear, worm shaft can be turned to rotate lever back to original setting.

SLACK ADJUSTER SERVICEABILITY TEST

Adjust brakes as previously directed under "Brake Adjustment" in this section; then carefully measure brake chamber push rod travel as brakes are applied. Make several full brake applications and again measure push rod travel. Push rod travel should be the same as it was immediately after adjustment. If push rod travel increases, or if difficulty is experienced in keeping the brakes adjusted in service, the slack adjuster must be overhauled or replaced.



1 Slack Adjuster
2 Push Rod Yoke
3 Brake Chamber Bracket
4 Brake Chamber
5 Brake Chamber Mounting Stud
6 Camshaft
7 Snap Ring
8 Washer
9 Slack Adjuster Worm Shaft

TPM-6907

Figure 29—Brake Chamber, Bracket, and Slack Adjuster Mounted on Front Axle

SLACK ADJUSTER REPLACEMENT

Removal (Fig. 29 or 30)

1. Remove clevis pin attaching slack adjuster to brake chamber push rod.
2. Remove snap ring (front) or bolt and washers (rear) securing slack adjuster on camshaft. Slide slack adjuster off end of shaft.

Installation (Fig. 29 or 30)

1. If a new slack adjuster is being installed, make sure it is the same size and type as the one removed. Slide slack adjuster onto camshaft and attach with bolt and washers (rear) or with snap ring (front).
2. Connect brake chamber push rod to slack adjuster, using clevis pin and new cotter pin.
3. Lubricate slack adjuster as directed in LUBRICATION (SEC. 13) of this manual.
4. Adjust brakes as previously directed under "Brake Adjustments."

SLACK ADJUSTER OVERHAUL

Disassembly (Fig. 28)

1. Remove dirt and grease from outside of slack adjuster by washing in suitable cleaning solvent.

2. Cut off riveted ends of rivets attaching cover plates to body. Drive out rivets and remove cover plates.

3. Remove welch plug from end of worm shaft bore. Insert a flat end punch into the worm shaft bore and drive worm shaft out of body and worm.

4. Remove lock sleeve and spring from worm shaft. Remove gear and worm from slack adjuster body. Remove lubrication fitting.

Cleaning, Inspection, and Repair

1. Wash parts in cleaning solvent and wipe or blow parts dry.

2. Inspect worm and gear and replace with new parts if chipped or broken teeth are evident.

3. Inspect worm shaft for wear. Make sure corners on hex end are not rounded.

4. Inspect bushing in lever arm. If worn, out-of-round, or otherwise damaged, it must be replaced. To replace bushing, press old bushing out and press new bushing into place. Bushing must be reamed after installation to 0.501"-0.503".

5. Examine lock sleeve for cracks or other damage. Replace if necessary.

6. Examine lever (body) for cracks or distortion. If lever is damaged in any way, a new body and bushing assembly must be used.

Assembly (Fig. 28)

1. Place worm and gear assembly in position in body.

2. Place lock sleeve over worm shaft, with socket-like end of sleeve at hex end of shaft. Place lock spring in recess formed by sleeve and shaft.

3. Enter small end of worm shaft through hole in body and worm. Press worm shaft into worm and body, making sure groove in lock sleeve is aligned with pin in body. Press shaft in until distance from small end of shaft to edge of body (A, fig. 28) is as follows: Front - 5/8" - Rear - 9/16". Install welch plug in worm shaft bore.

4. Position cover plates on body and attach with new rivets. Covers must be flat and in good contact with body after riveting.

5. Install lubrication fitting in body. Connect a grease gun to fitting and force grease into slack adjuster until it is completely filled. Refer to LUBRICATION (SEC. 13) for type lubricant to be used.

FRONT BRAKE SHOES, LININGS, AND CAMSHAFTS

SHOES AND LININGS

Brakes at each front wheel have two shoes which pivot on anchor pins at one end and are expanded at the other end during brake application by constant lift S-type cams (fig. 31). Brake shoe return springs hold shoe rollers firmly against cam. Two-piece block type lining is bolted to each

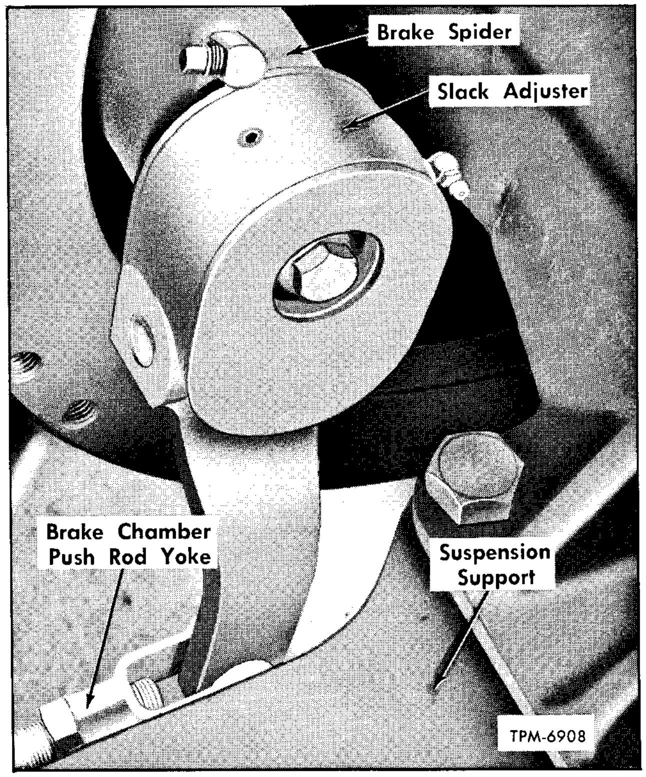


Figure 30—Slack Adjuster and Camshaft Mounted on Rear Axle

shoe. Holes through lining and upper shoe at cam end are provided to facilitate removal and installation of return springs.

Cam end of each shoe is equipped with a roller which forms the contact between shoe and cam (fig. 31). Anchor pin ends of shoes are equipped with replaceable bushings.

ANCHOR PINS

Anchor pin end of each shoe fits between brackets at brake spider, and is retained by straight type anchor pin (fig. 31). Both anchor pins are held in place by a lock plate which engages notches in end of each pin and is attached to brake spider by a lock bolt. Lubrication fittings are provided in each anchor pin so they can be lubricated at regular lubrication intervals. Refer to figure 31.

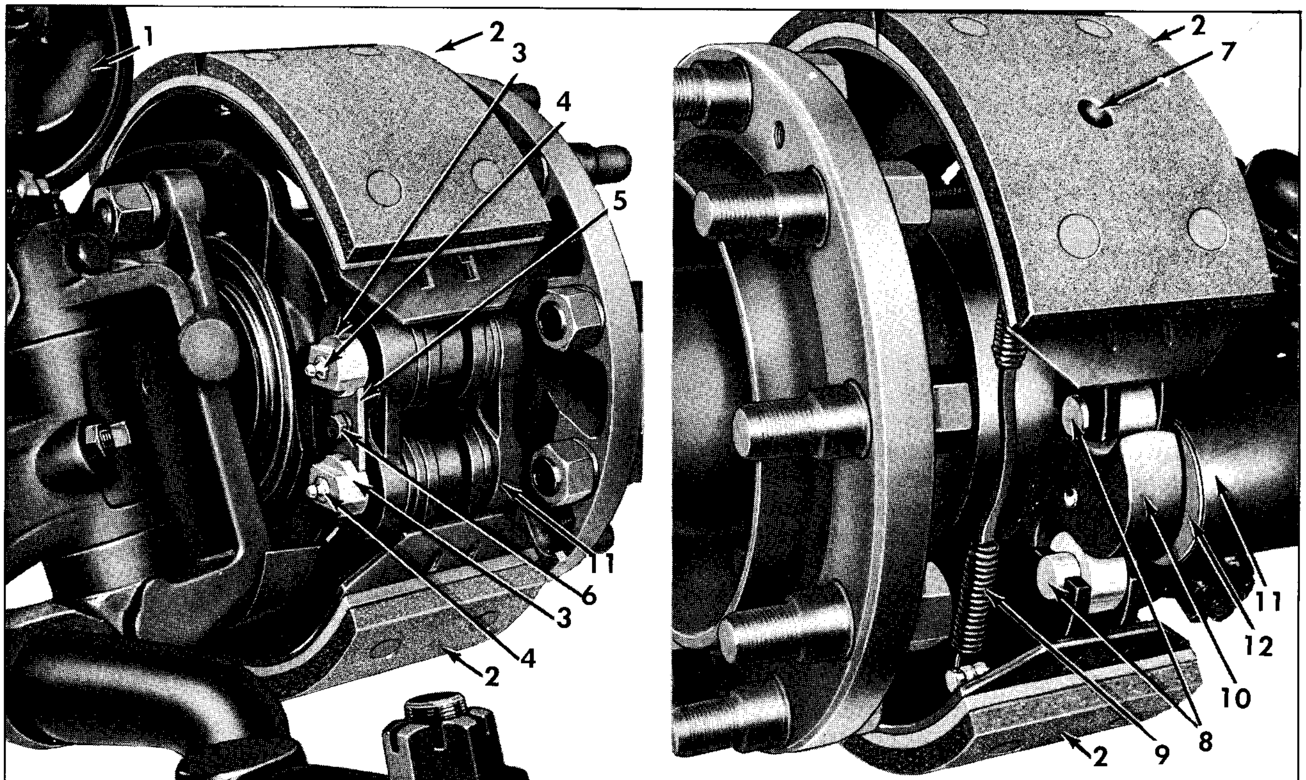
CAMSHAFTS

Front brake camshafts are mounted in bushings in brake spider (fig. 32). Lubrication fitting in spider provides a method for lubricating bushings. Lubricant is retained by oil seals which are pressed into brake spider.

FRONT BRAKE SHOE AND CAMSHAFT REMOVAL

1. Jack up axle and remove wheel and brake drum. Remove hub as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.

AIR BRAKES



1 Brake Chamber	5 Lock Plate	9 Return Spring
2 Brake Shoe and Lining Assy.	6 Lock Bolt	10 Camshaft
3 Anchor Pins	7 Return Spring Access Hole	11 Brake Spider
4 Lubrication Fittings	8 Rollers	12 Washers

Figure 31—Front Brake Shoes Installed

2. Drive plugs out of lining at cam end of upper shoes using a punch through holes in shoes. Using a hooked tool through holes in lining and shoes, unhook return springs from pin in upper shoes. Remove springs from pin in lower shoes. Tag or mark brake shoes so that they may be reinstalled in original position.

3. Remove lock bolt and washer; then remove anchor pin lock plate. Drive anchor pins out of brake spider and shoes; then remove brake shoes.

4. To remove camshaft (fig. 32), disconnect brake chamber push rod yoke from slack adjuster. Remove snap ring and washer securing slack adjuster on camshaft and pull slack adjuster off end of shaft. Pull camshaft out of brake spider, stripping spacing washers off shaft as shaft is removed.

INSPECTION

1. Wash all parts except shoe and lining assemblies in cleaning solvent. Check anchor pins and brake shoe bushings for wear in accordance with dimensions listed in "Specifications" at end of this group. Replace with new parts any that are worn or damaged. If brake shoe bushings are replaced, burnish after installation.

2. Examine camshaft bushings, spacer, and seals. If there is any indication of wear or damage, remove old parts and replace with new. Remove bushings and seals by inserting tool through spider and tapping on inside end of each bushing. When installing new bushings, carefully drive into place with a suitable driver. Install spacer between bushings. New seals should be soaked in oil until soft and pliable before installing, and should be installed with tapered edge out to permit installing camshaft without damaging seals.

3. Check fit of roller hubs in shoes. If excessive looseness is evident, remove rollers and check for wear. Replace worn parts. Lubricate roller hubs before installing.

4. Check tension of brake shoe return springs. Replace if weak or broken.

5. Check thickness of brake lining at center of shoe. If worn down to 5/16" thickness, lining should be replaced. When replacing linings, lining with return spring access holes must be installed at cam end of upper shoe. Linings must be securely bolted to shoes. New lock washers should be

used and nuts tightened to 20-25 foot-pounds torque. A 0.006" feeler gauge must not enter between shoe and lining at any point. Drive lining plugs into bolt holes in lining when installation is completed. Make sure roller in shoe is standard size when new linings are installed.

6. Examine camshaft for cracks, distortion, or wear at the bearing surfaces. Replace if worn or damaged.

FRONT CAMSHAFT AND BRAKE SHOE INSTALLATION

1. Work lubricant into camshaft bushings. Refer to LUBRICATION (SEC. 13) for type lubricant to be used.

2. Install large spacing washer on camshaft and insert camshaft through bushings in spider (fig. 32), being careful not to damage seals.

3. Install brake shoes at brake spider in same position from which they were removed. Coat anchor pins with lubricant and insert through brake spider and shoes. Turn anchor pins so notches in inner end face each other. Install anchor pin lock plate and secure with lock bolt and lock washer (fig. 31).

4. Apply a thin coat of grease containing zinc oxide (#3) on O.D. of spring coils. Hook one end of brake shoe return springs on pins in lower brake shoes. Stretch springs and hook onto pins in upper shoes, using hooked tool through holes in lining and shoes. Drive lining plugs into holes after hooking springs.

5. Place spacing washers over inner end of camshaft (fig. 32), install slack adjuster on camshaft, and secure with washers and snap ring. Connect brake chamber push rod yoke to slack adjuster, using clevis pin and cotter pin. Back off slack adjuster worm shaft until shoe rollers rest on lowest points on cam.

6. Install hubs, drums, and wheels, and adjust bearings as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.

7. Adjust brakes as previously directed under "Brake Adjustment" in this section.

8. Lubricate slack adjuster and camshaft bushings as directed in LUBRICATION (SEC. 13) of this manual.

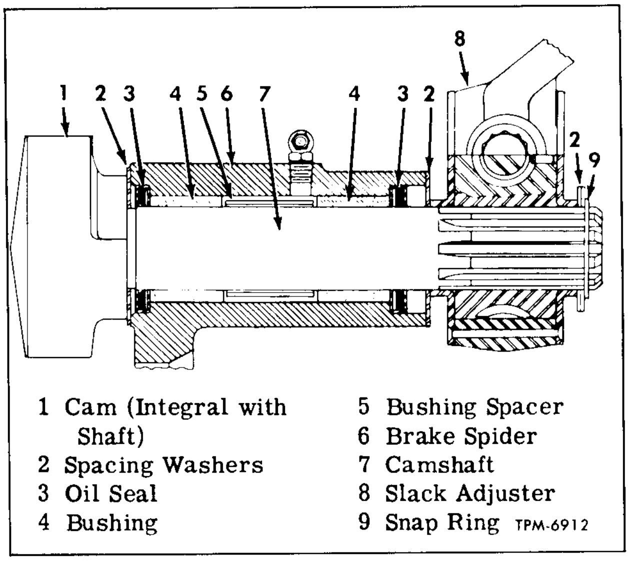


Figure 32—Front Brake Camshaft and Slack Adjuster Mounting

REAR BRAKE SHOES, LININGS, AND CAMSHAFTS

SHOES AND LININGS

Brakes at each rear wheel have two shoes (fig. 33). Two-piece block type lining is bolted to each shoe. The hole through lining and shoe table at cam end is used for removing and installing springs. Shoes pivot at one end on anchor pins and ride at other end on rollers (fig. 33). Roller ends of shoes are extended during brake application by constant lift S-type cams. Anchor pin ends of shoes have replaceable bushings.

ANCHOR PINS

The anchor pin acts as a rigid pivot point for fixed end of shoe. Lock bolt in spider extends through hole in bushing and seats in pin groove. The two lock bolts are wired together (fig. 33).

CAMSHAFTS

Camshafts are mounted in bushings in brake spider. Mounting is similar to front camshaft mounting shown in figure 32. Lubrication fitting in spider lubricates bushings. Lubricant is retained by seals pressed into spider.

REAR BRAKE SHOE REMOVAL

1. Jack up axle and remove wheels and brake drums. Remove hubs as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.

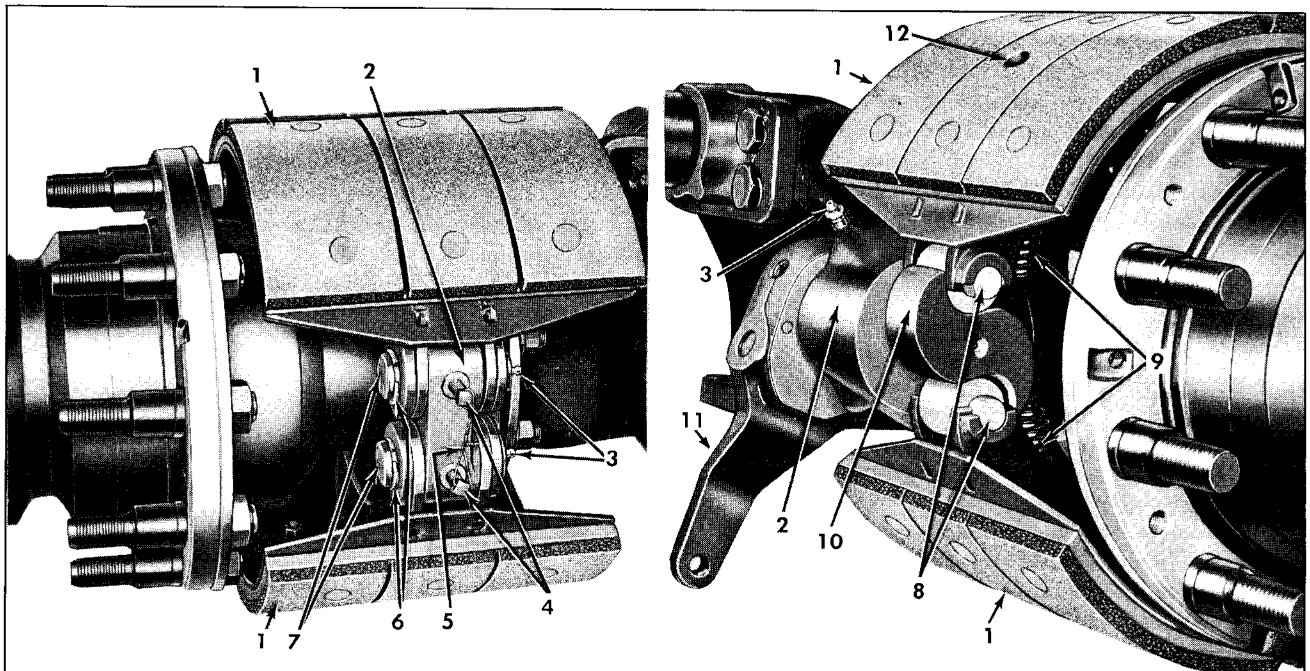
2. Drive plugs out of lining at cam end of upper shoes. Using a hooked tool through holes in linings and shoes, unhook springs from pins in upper shoes. Remove springs from pins in lower shoes.

3. Tag or mark shoes so that they may be reinstalled in original position. Remove lock wire and lock bolts from spider. Remove anchor pins and brake shoes.

BRAKE SHOE INSPECTION

1. Check anchor pins and brake shoe bushings for wear using "Specifications" at end of this group. Replace badly worn parts with new parts. Burnish brake shoe bushings after installation.

2. Check fit of roller hubs in shoes. Replace



1 Brake Shoe and Lining Assy.
2 Brake Spider
3 Lubrication Fittings
4 Lock Bolts
5 Lock Wire
6 Anchor Pin Lock
7 Anchor Pins
8 Rollers
9 Return Spring
10 Camshaft
11 Slack Adjuster
12 Return Spring Access Hole

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Figure 33—Rear Brake Shoes Installed (Typical)

worn parts. Lubricate roller hubs before installing rollers.

3. Check tension of brake shoe return springs, Replace weak or broken springs.

4. Check thickness of brake lining at center of shoe. If worn down to 5/16" thickness, lining must be replaced. When replacing linings, lining with return spring access holes must be installed at cam end of upper shoes. Linings must be securely bolted to shoes. New lock washers should be used and nuts should be tightened to 20-25 foot-pounds torque. A 0.006" feeler must not enter between lining and shoe at any point. Drive lining plugs into bolt holes in lining when installation is completed.

REAR BRAKE SHOE INSTALLATION

1. Coat anchor pins, O.D. of shoe return spring coils, and brake shoe roller hubs with lubricant recommended in LUBRICATION (SEC. 13) of this manual.

2. Position each brake shoe heel at spider. Install anchor pins and pin lock bolts; then tighten bolts firmly. Thread lock wire through bolt heads and twist ends of wire together (fig. 33).

3. Hook one end of brake shoe return springs on pins, on lower shoes. Place roller in toe of each shoe. Stretch springs and hook on spring pins in upper shoes. Use hooked tool through hole in lining and shoes. Drive lining plugs into holes after hooking springs.

4. Back off slack adjuster worm shaft until shoe rollers rest on lowest points on cam. Install hubs, brake drums, and wheels as directed in "HUBS AND BEARINGS" (SEC. 19) of this manual.

5. Adjust brake shoes as previously directed under "Brake Adjustments" in this section.

REAR CAMSHAFT REMOVAL

1. Unhook brake shoes as directed in "Rear Brake Shoe Removal" steps 1 and 2. Swing brake shoes away from cam. Rear camshaft mounting is similar to front mounting shown in figure 32.

2. Disconnect brake chamber push rod yoke from slack adjuster. Remove bolt, lock washer, and flat washer securing slack adjuster on camshaft.

3. Pull slack adjuster off end of shaft. Pull camshaft out of brake spider, stripping off spacing washers as shaft is removed.

CAMSHAFT INSPECTION

1. Wash all parts in cleaning solvent. Wipe or blow parts dry.

2. Examine camshaft for cracks, distortion, or wear at bushing surface. Replace if worn or damaged.

3. Examine bushings in brake spider. Replace with new bushings if wear or damage is evident. Remove bushings and seals by inserting tool through spider and tapping on inside end of each bushing. Soak new oil seals in oil for one hour before installing in spider.

REAR CAMSHAFT INSTALLATION

1. Coat bushings in brake spider with lubricant recommended in LUBRICATION (SEC. 13) of this manual.
2. Place large spacing washer over splined end of camshaft.
3. Insert splined end of shaft through bushings in brake spider.
4. Install spacing washer and slack adjuster on inner end of camshaft. Attach with flat washer, lock washer, and bolt. Connect brake chamber push rod to slack adjuster.
5. Secure brake shoes as directed in "Rear Brake Shoe Installation," steps 3 and 4.
6. Adjust brake shoes as previously directed under "Brake Adjustments." Lubricate spider bushings, anchor pins, and slack adjuster as directed in LUBRICATION (SEC. 13) of this manual.

BRAKE DRUM VIBRATION DAMPERS

Four brake drum vibration dampers are installed on each rear brake drum. Each damper is attached with two bolts as shown in figure 34. Dampers are made of spring steel and push against inside of wheel rim. Keep attaching bolts firmly tightened. If difficulty is experienced in removing and installing inner wheel, loosen damper attaching bolts.

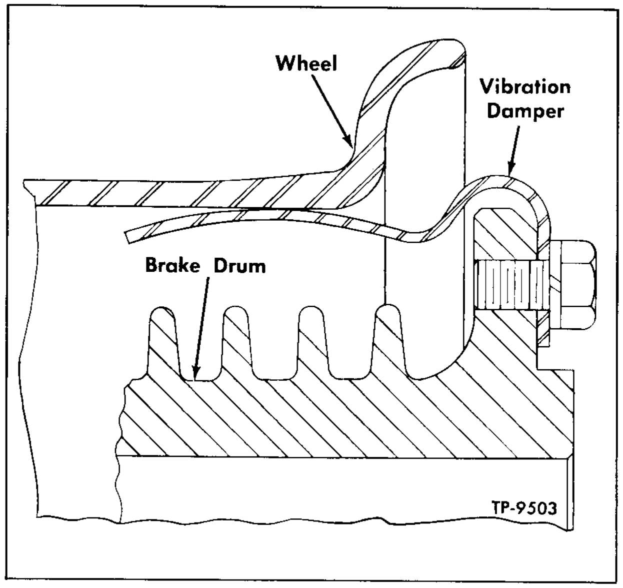


Figure 34—Rear Brake Drum Vibration Damper

REFER TO NEXT PAGE FOR AIR BRAKE SPECIFICATIONS.

AIR BRAKES

SPECIFICATIONS

	TDH-4516 TDH-4517 TDM-4517 SDH-4501 SDM-4501		TDH-5301 TDH-5302 SDH-5301 TDM-5301 TDM-5302 SDM-5301	
	Front	**Rear**	**Front**	**Rear**
BRAKE SIZE	$14\frac{1}{2}$" x 4"	$14\frac{1}{2}$" x 8"	$14\frac{1}{2}$" x 5"	$14\frac{1}{2}$" x 10"
BRAKE DRUM				
Inside Diameter	14.500"-14.510"	14.500"-14.510"	14.500"-14.510"	14.500"-14.510"
Max. Allowable Out-of-round	0.625"	0.625"	0.625"	0.625"
Width Braking Surface	4"	8"	5"	10"
BRAKE LINING				
Width	4"	8"	5"	10"
Thickness	$\frac{3}{4}$"	$\frac{3}{4}$"	$\frac{3}{4}$"	$\frac{3}{4}$"
Piece Per Shoe	2	2	2	2
Length—Each Piece	7.33"	7.33"	7.33"	7.33"
Effective Brake Area	118 Sq. In.	235 Sq. In.	147 Sq. In.	293 Sq. In.
BRAKE SHOE RETURN SPRING				
Free Length	$8\frac{11}{16}$"	$8\frac{1}{2}$"	$8\frac{11}{16}$	$8\frac{1}{2}$"
Length @ Lbs. Pull	$9\frac{13}{32}$" @ 32-38	$9\frac{13}{32}$" @ 113-137	$9\frac{13}{32}$" @ 32-38	$9\frac{13}{32}$" @ 113-137
CAMSHAFT				
Length	$9\frac{11}{16}$"	$8\frac{19}{32}$"	$9\frac{11}{16}$"	$7\frac{23}{32}$"
Width of Cam	$1\frac{3}{4}$"	$2\frac{15}{64}$"	$1\frac{3}{4}$"	$2\frac{15}{64}$"
Outside Diameter of Cam	$3\frac{7}{8}$"	$3\frac{7}{8}$"	$3\frac{7}{8}$"	$3\frac{7}{8}$"
Outside Diameter of Shaft	1.493"-1.495"	1.493"-1.495"	1.493"-1.495"	1.493-1.495"
Number of Splines	10	10	10	10
CAM ROLLER IN SHOE				
Outside Diameter	1.488"-1.492"	1.488"-1.492"	1.488"-1.492"	1.488"-1.492"
Outside Diameter of Hub	0.740"-0.745"	0.740"-0.745"	0.740"-0.745"	0.740"-0.745"
Width of Roller	0.790"-0.800"	1.290"-1.300"	0.790"-0.800"	1.450"-1.460"
Width of Hubs	$\frac{15}{32}$"	0.494"-0.504"	$\frac{15}{32}$"	$\frac{19}{32}$"
BRAKE SHOE BUSHING				
Inside Diameter	1.250"-1.254"	1.250"-1.254"	1.250"-1.254"	1.255"-1.257"
Outside Diameter	1.498"-1.500"	1.498"-1.500"	1.498"-1.254"	1.503"-1.505"
Width	1.92"	1.92"	1.92"	$\frac{5}{8}$"
Bushing To Be Press Fit in Shoe	—	—	—	—
ANCHOR PINS				
Outside Diameter	1.248"-1.250"	1.2485"-1.2465"	1.248"-1.250"	1.2465"-1.2485"
Length	4.375"	$6\frac{7}{8}$"	4.375"	3.380"
Anchor Pins are Chrome-plated Lubrication Type	—	—	—	—
BRAKE CHAMBERS				
Type (Stamped on Unit)	"20"	"30"	"20"	"30"
Outside Diameter	$6\frac{25}{32}$"	$8\frac{1}{8}$"	$6\frac{25}{32}$"	$8\frac{1}{8}$"
Spring Force at 0 Stroke	$24\frac{1}{4}$ lbs.	*$39\frac{1}{2}$ lbs.	$24\frac{1}{4}$ lbs.	*$39\frac{1}{2}$ lbs.
Increase Per In. of Stroke	$6\frac{1}{4}$ lbs.	$10\frac{1}{2}$ lbs.	$6\frac{1}{4}$ lbs.	$10\frac{1}{2}$ lbs.
Minimum Stroke With Brake Adjusted		Short as possible without brakes dragging.		
Stroke	$2\frac{1}{4}$" + $\frac{1}{4}$" − $\frac{1}{16}$"	$2\frac{1}{2}$" + $\frac{1}{4}$" + $\frac{1}{16}$"	$2\frac{1}{4}$" + $\frac{1}{4}$" − $\frac{1}{16}$"	$2\frac{1}{2}$" + $\frac{1}{4}$" − $\frac{1}{16}$"
PUSH ROD SPRING				
Outside Diameter of Lg. Coils	$3\frac{1}{8}$"	$2\frac{31}{32}$"	$3\frac{1}{8}$"	$2\frac{31}{32}$"
Free Length Approximate	$7\frac{13}{64}$"	$7\frac{17}{32}$"	$7\frac{13}{16}$"	$7\frac{17}{32}$"
Compressed Length	$3\frac{3}{16}$" Under $25\frac{1}{4}$ lbs.	$3\frac{13}{16}$" Under $39\frac{1}{2}$ lbs.	$3\frac{3}{16}$" Under $25\frac{1}{4}$ lbs.	$3\frac{13}{16}$" Under $39\frac{1}{2}$ lbs.
Solid Length	$\frac{13}{16}$" (Max.)	$1\frac{1}{8}$" (Max.)	$\frac{13}{16}$" (Max.)	$1\frac{1}{8}$" (Max.)
SLACK ADJUSTERS				
Type	"15—2"	"20—2"	"15—2"	"20—2"
Bushing I.D.	0.501"-0.504"	0.501"-0.504"	0.501"-0.504"	0.501"-0.504"
No. of Bushings	3	1	3	1
No. of Springs	10	10	10	10
Diameter of Spline	$1\frac{1}{2}$"	1.505"-1.515"	$1\frac{1}{2}$"	1.505"-1.515"
Offset of Lever	$\frac{5}{8}$"	$1\frac{1}{2}$"	$\frac{5}{8}$"	$1\frac{1}{2}$"

*On late models (without boot), spring force at 0 stroke is 90 lbs.

Air Compressor and Governor

(BENDIX-WESTINGHOUSE)

AIR COMPRESSOR

The air compressor is a two-cylinder single-acting, reciprocating type unit. Compressor is flange mounted to the gear train cover at rear end of the engine. Compressor is driven directly from the engine camshaft, and lubricated by the engine lubrication system. The cylinder head and cylinder block are cooled by engine cooling system. Compressor has a rated capacity of 12 cu. ft. per minute based on piston displacement when running at a speed of 1250 rpm.

AIR COMPRESSOR DRIVE AND LUBRICATION

Typical compressor drive is shown in figure 1. A hub with internal fiber teeth is keyed to front end of the compressor crankshaft and secured by a nut and cotter pin. An internal-toothed fiber drive disc is attached to the engine camshaft gear by four cap screws. A drive coupling with external teeth at each end is carried in internal teeth of the hub and drive disc, transmitting power from drive disc to the air compressor crankshaft hub.

Oil, under pressure from the engine lubrication system, enters drilled crankshaft through crankshaft rear end cover and is forced through crankshaft and drilled connecting rods (figs. 8 and 9), lubricating bearings, piston pins, and pistons. On early model compressors, an oil return tube (fig. 1) connects the compressor crankcase bottom cover to openings in the mounting flange and engine gear train cover. Oil drains from the crankcase bottom cover into the engine gear train cover, and then into the engine crankcase.

On late model compressors, oil return is cast integral with compressor crankcase, and the external oil return tube is not used.

Two vent holes through the crankcase above the crankshaft front bearing permit equalization of the compressor crankcase pressure with the engine crankcase pressure.

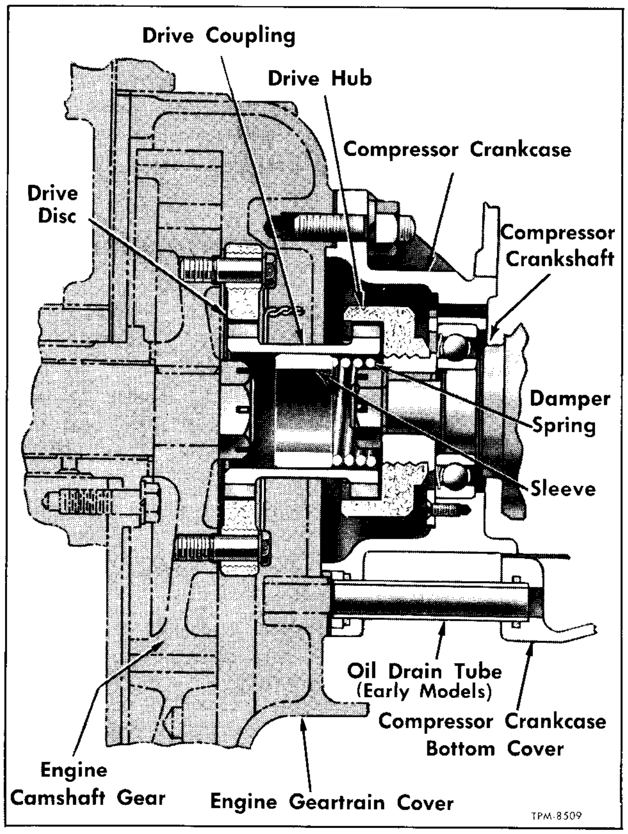


Figure 1—Air Compressor Drive (Typical)

AIR COMPRESSOR AIR INTAKE

The air compressor air inlet port is connected by a tube to the engine air cleaner manifold. The air drawn into the air compressor is cleaned by the engine air cleaners.

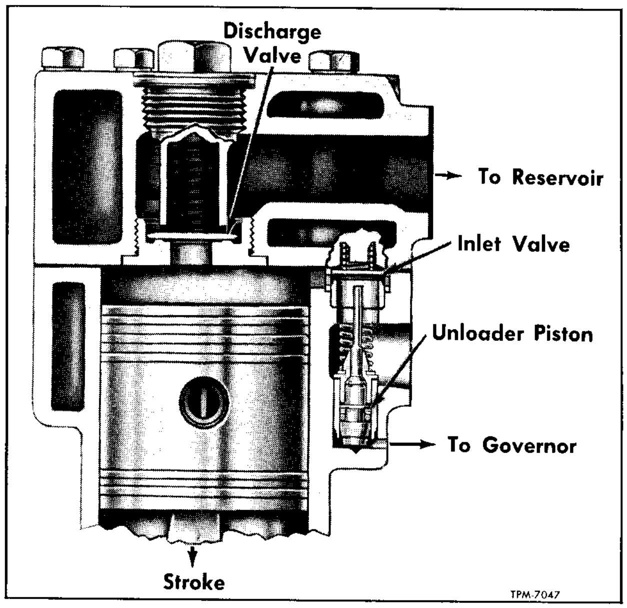


Figure 2—Intake of Air

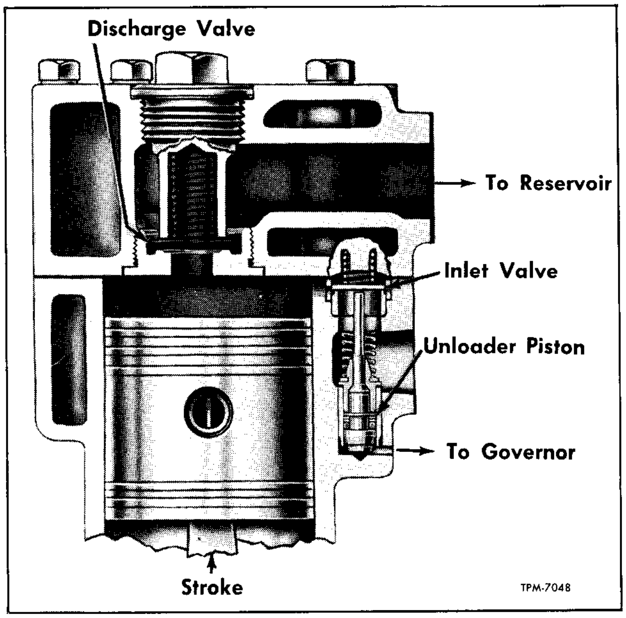


Figure 3—Compression of Air

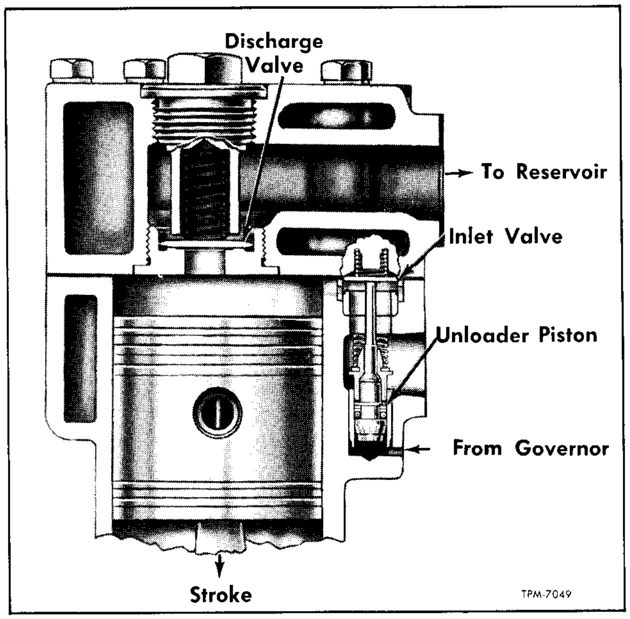


Figure 4—Unloading Compressor

AIR COMPRESSOR OPERATION

Air compressor crankshaft turns continuously while engine is running. Actual compression of air is controlled by the compressor governor, however. Acting with compressor unloading mechanism, governor controls compression of air by loading or unloading compressor when pressure in air system reaches the desired high or low point.

OPERATION WITH UNLOADER VALVE CLOSED (COMPRESSING) (Figs. 2 and 3)

During the downstroke, a partial vacuum is created above each piston. Intake air forces open the inlet valve and air fills cylinder.

As piston starts upstroke, air pressure on top of inlet valve plus inlet valve return spring force closes the inlet valve. As air above piston is further compressed, pressure lifts discharge valve and compressed air is forced through discharge line into reservoir. At start of downstroke discharge valve returns to seat, blocking return flow of compressed air to cylinder as cycle is repeated.

OPERATION WITH UNLOADER VALVES OPEN (NOT COMPRESSING) (Fig. 4)

When air in system reaches maximum pressure for which governor is set, air passes through governor into unloader cavity below unloader piston cups in compressor cylinder block. Upward movement of unloader pistons caused by air pressure lifts both air inlet valves off inlet valve seats. With both inlet valves unseated, air intake cavity in the cylinder block forms a passage between cylinders above the pistons. Upstroke of one piston exhausts air into cylinder of other piston on downstroke, without compression.

When pressure in air system is reduced to governor cut-in setting, the governor releases pressure from beneath unloader pistons. Pressure of unloader spring on unloader spring saddle, acting against reduced governor pressure, forces pistons away from inlet valves. As inlet valve springs in turn overcome reduced plunger pressure, inlet valves reseat and compression is resumed.

AIR COMPRESSOR MAINTENANCE

It is important that inspection and adjustments listed below be made at intervals determined by severity of service.

1. Remove cylinder head and clean carbon away from discharge valves and inlet valves.
2. Check compressor discharge line. Make sure line is not choked with carbon.
3. Check compressor mounting bolts and tighten if necessary.
4. Make sure oil and air lines and connections are tight and free from leaks.
5. When draining engine cooling system to prevent freezing, be sure and remove drain plug from compressor cylinder block.

UNLOADER ASSEMBLY REPLACEMENT

Parts are available in a kit for replacing unloader assembly components. Unloader parts (fig. 5) may be changed without removing cylinder head. Replace parts as follows:

REMOVAL (Fig. 6)

1. Remove air inlet elbow and gasket. Discard gasket.
2. Insert screwdriver blade under unloader spring and raise spring off unloader spring saddle. Remove spring, spring seat, and spring saddle.
3. Lift each plunger guide and remove guide and plunger. Lift pistons out of bores. If piston is not easily removed, build up air pressure in system until governor cuts out raising piston. If compressor has been removed from vehicle, use air pressure as shown in figure 6.

INSTALLATION (Fig. 7)

1. Carefully insert each piston, complete with new O-ring and back-up ring, in bore.
2. Slide plunger guide down over unloader plunger. Place each guide and plunger in position above unloader piston, then push guide down over top of piston.
3. Install unloader spring seat, spring saddle, and spring.

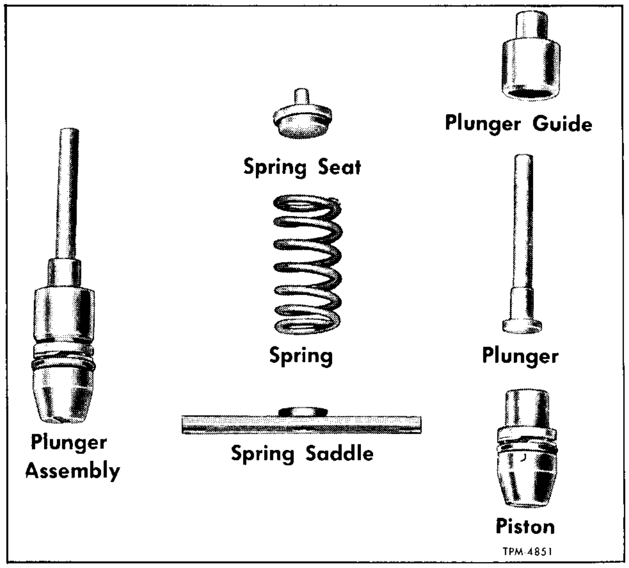


Figure 5—Unloader Assembly Components

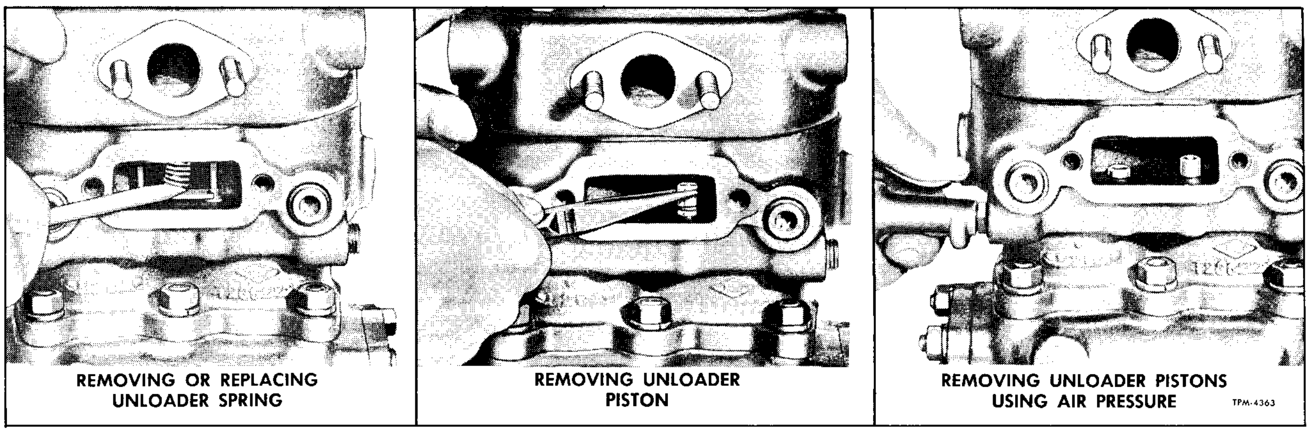


Figure 6—Removing Unloader Components

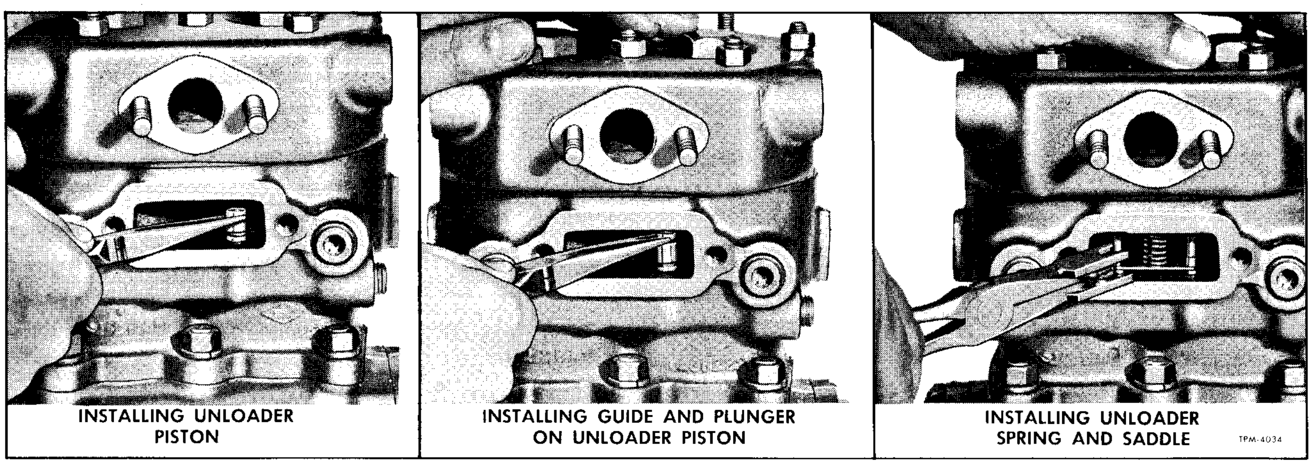


Figure 7—Installing Unloader Components

4. Install new gasket at air inlet and connect air inlet elbow. Tighten bolts firmly.

AIR COMPRESSOR REPLACEMENT

REMOVAL (Fig. 1)

1. Drain engine cooling system.
2. Disconnect water, air, and oil lines from air compressor.
3. Remove nuts and lock washers from four studs attaching air compressor to gear train cover. Pull compressor straight back off studs and remove from vehicle.

INSTALLATION (Fig. 1)

1. Clean oil supply line to compressor, and if possible, run engine a few seconds to be sure oil supply to compressor is flowing freely.
2. Clean oil passage in compressor crankcase.
3. Lubricate compressor cylinder walls and bearings with lubricating oil before placing compressor in position.
4. Clean or replace any damaged or dirty air lines or water lines which may be corroded before connecting them to the compressor.
5. Before installing compressor, examine hub on compressor crankshaft and drive disc on camshaft gear for worn or broken teeth. Check backlash between teeth in hub and teeth on drive coupling, also between teeth in drive disc and teeth on coupling. New limits are 0.000" to 0.001" backlash. If backlash is appreciably greater than this, drive disc or hub (or both) must be replaced.
6. Make sure mating surfaces of air compressor flange and gear train cover are clean. Place new compressor to gear train cover gasket on studs. Make sure gasket around oil return tube (on early models) is in place and in good condition.
7. Insert damper spring in drive coupling and place spring end of drive coupling into hub on compressor crankshaft. Place compressor in position on gear train cover, guiding teeth on coupling in to mesh with teeth in drive disc. Install nuts and lock washers on studs and tighten firmly.
8. Connect all water, air, and oil lines, making sure connections are tight.
9. Make sure drain plug is installed in compressor cylinder block, then fill cooling system.

AIR COMPRESSOR OVERHAUL

COMPRESSOR DISASSEMBLY

The crankcase, crankcase bottom cover, cylinder block, and cylinder head are so designed that method of assembly may be varied to meet different installation requirements. These parts should be marked before disassembling, so they can be reassembled in same position.

NOTE: Key numbers in text refer to figure 8.

CYLINDER HEAD REMOVAL AND DISASSEMBLY

1. Remove all cylinder head cap screws, then lift off cylinder head assembly (1). Tap head with soft hammer, if necessary, to break gasket joint.
2. Scrape cylinder head and block, if necessary, to remove any part of gasket (2) sticking to gasket surface.
3. Remove discharge valve cap nuts (36) and lift out discharge valve springs (35) and discharge valves (34). Remove discharge valve seats (33). Remove inlet valve springs (37) and inlet valves (32) from top of cylinder block.

PISTON AND CONNECTING ROD REMOVAL AND DISASSEMBLY

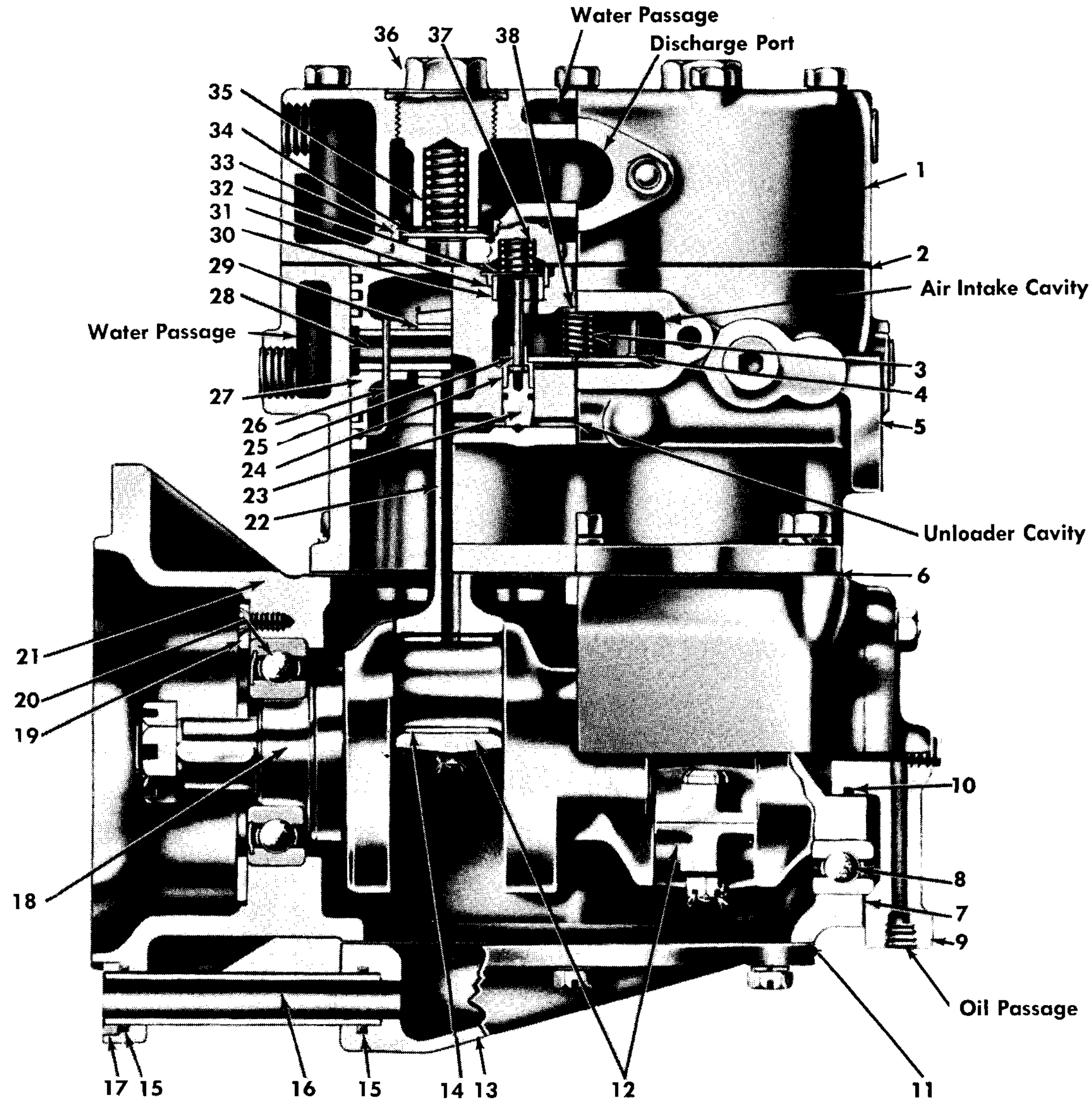
1. Remove screws and lock washers attaching crankcase bottom cover (13) to crankcase, and remove cover and gasket (11). Remove oil drain tube (16) (when used).
2. Before removing, mark each piston. Marks will be used to reassemble parts in original position. Connecting rods and caps have center punch marks showing proper position of cap on rod.
3. Remove cotter pins and nuts from connecting rod bolts. Remove connecting rod bearing caps (12) and bearing inserts (14). Do not remove bolts from rods. Push pistons with connecting rods attached out top of cylinder block. Replace caps on rods with inserts in place to prevent damage to bearing inserts.
4. Remove piston rings from pistons. If connecting rods are to be removed from pistons, remove piston pin lock wires (26), then press piston pins (28) out of pistons and connecting rods.

CRANKSHAFT REMOVAL

1. Remove cotter pin and nut from front end of crankshaft and pull drive hub off shaft. Remove drive hub key from keyway in shaft.
2. Remove cap screws attaching rear end cover (9) to crankcase and remove cover and gasket (7). Remove oil seal ring (10) from boss on cover.

NOTE: On late model compressors, crankshaft rear bearing will come off with end cover.

3. On early compressors remove three screws attaching crankshaft front bearing retainer (19) to crankcase and remove retainer.
4. Place crankcase on arbor press bed, front (drive) end up, and place blocks under crankcase so pressure will not be placed on rear end cover studs. Pressing on front end of crankshaft press crankshaft out of front bearing. Remove crankshaft



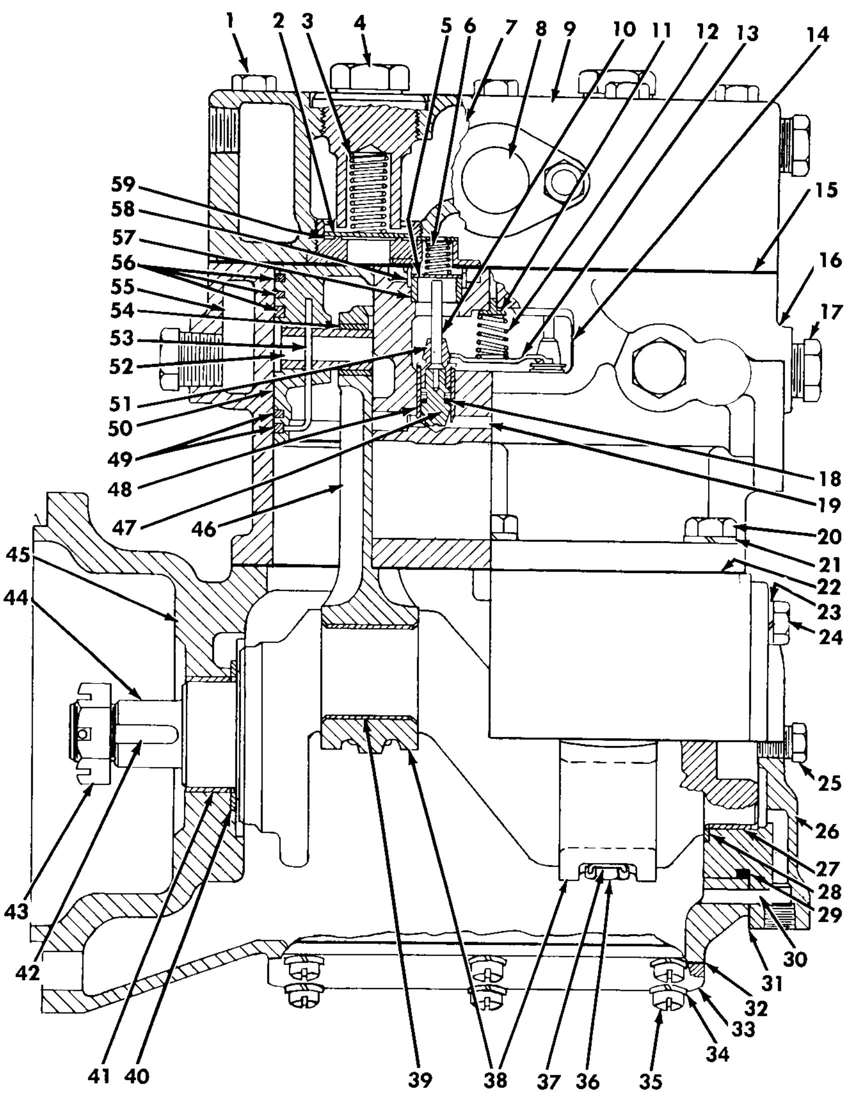
1 Cylinder Head
2 Cylinder Head Gasket
3 Unloader Spring
4 Unloader Spring Saddle
5 Cylinder Block
6 Cylinder Block Gasket
7 End Cover Gasket
8 Crankshaft Rear Bearing
9 Crankcase Rear End Cover
10 Cover Oil Seal Ring
11 Crankcase Bottom Cover Gasket
12 Connecting Rod Bearing Cap
13 Crankcase Bottom Cover
14 Connecting Rod Bearing Insert
*15 Oil Drain Tube Seal
*16 Oil Drain Tube
*17 Oil Drain Tube Gasket
18 Crankshaft
19 Crankshaft Front Bearing Retainer
20 Crankshaft Front Bearing
21 Crankcase
22 Connecting Rod
23 Unloader Piston
24 Unloader Plunger Guide
25 Unloader Plunger
26 Piston Pin Lock Wire
27 Piston
28 Piston Pin
29 Connecting Rod Bushing
30 Inlet Valve Seat
31 Inlet Valve Guide
32 Inlet Valve
33 Discharge Valve Seat
34 Discharge Valve
35 Discharge Valve Spring
36 Discharge Valve Cap Nut
37 Inlet Valve Spring
38 Unloader Spring Seat

* On late models, oil return is cast integral with compressor crankcase, eliminating items 15, 16, and 17.

TPM-8508-1

Figure 8—Air Compressor Assembly (Early Model)

AIR COMP. AND GOVERNOR (B-W)



1 Cap Screw
2 Discharge Valve
3 Discharge Valve Spring
4 Discharge Valve Cap Nut
5 Inlet Valve
6 Inlet Valve Spring
7 Water Passage
8 Discharge Port
9 Cylinder Head
10 Unloader Plunger
11 Unloader Spring Seat
12 Unloader Spring
13 Unloader Spring Saddle
14 Air Intake Cavity
15 Gasket
16 Cylinder Block
17 Pipe Plug
18 Grommet
19 Unloader Cavity
20 Cap Screw
21 Lock Washer
22 Gasket
23 Lock Washer
24 Cap Screw
25 Pipe Plug
26 Rear End Cover
27 Crankshaft Rear Bearing
28 Crankshaft Rear Thrust Washer
29 End Cover Oil Seal
30 Oil Supply
31 Gasket
32 Gasket
33 Crankcase Cover
34 Lock Washer
35 Screw
36 Nut
37 Lock Washer
38 Connecting Rod Bearing Cap
39 Connecting Rod Bearing
40 Crankshaft Front Thrust Washer
41 Crankshaft Front Bearing
42 Crankshaft Key
43 Crankshaft Nut
44 Crankshaft
45 Crankcase
46 Connecting Rod
47 Unloader Piston
48 Bushing
49 Oil Control Rings
50 Piston
51 Unloader Plunger Guide
52 Piston Pin
53 Piston Pin Lock Wire
54 Connecting Rod Bushing
55 Water Passage
56 Compression Rings
57 Inlet Valve Seat
58 Inlet Valve Guide
59 Discharge Valve Seat TPM-9348-1

Figure 9—Air Compressor Assembly (Late Model)

through rear end cover opening.

NOTE: On early model compressors, crankshaft rear bearing will come out with crankshaft.

5. On early model compressors, using a suitable puller, pull rear bearing (8) off crankshaft. Using a bearing driver from inside of crankcase, drive front bearing (20) out of crankcase.

6. On late model compressors, remove crankcase front and rear thrust washers. Do not remove crankshaft bearings from crankcase and end cover unless inspection shows necessity for removal.

CYLINDER BLOCK REMOVAL
AND DISASSEMBLY

1. Remove bolts and lock washers securing air compressor governor to cylinder block, then

remove governor and governor gasket. Discard gasket.

2. Remove cap screws securing cylinder block (5) to crankcase (21), then remove cylinder block and cylinder block gasket (6). Discard gasket.

3. Remove unloader spring (3) and unloader spring saddle (4).

4. Remove unloader plungers (25), plunger guides (24), and unloader pistons (23). Remove inlet valve guides (31). NOTE: It may be necessary to use air pressure (with caution) at the governor port of the cylinder block to remove the unloader pistons, after removing the unloader plunger and associated parts.

CLEANING AND INSPECTION OF COMPRESSOR PARTS

CLEANING

1. General. Thoroughly wash all parts in a suitable cleaning solvent to remove all traces of dirt, oil, or grease.

2. Cylinder Head. Soak cylinder head in cleaning solvent to loosen carbon from discharge valve cavities and unloading cavity, and to loosen rust and scale. Blow dirt out of all cavities with compressed air. Scrape carbon and dirt from all surfaces. Scrape gasket particles from gasket surfaces.

3. Discharge Valves. Clean discharge valves, if not worn excessively or damaged, by lapping with crocus cloth held on a flat surface.

4. Oil Passages. Thoroughly clean oil passages through crankshaft, connecting rods, and crankcase rear end cover. If necessary, prod oil passages with a piece of wire; then flush passages with cleaning solvent and blow out with compressed air.

5. Cylinder Block. Soak cylinder block in cleaning solvent to loosen carbon and dirt from air intake cavity. Clean rust and scale from water passages. Blow out all passages with compressed air.

6. Pistons. Scrape all carbon and dirt out of ring grooves in pistons. Clean drain holes in oil ring grooves.

7. Ball Bearings. On early model compressors, immerse bearings in cleaning solvent, then brush off old lubricant. Blow bearings dry with compressed air, and wrap in clean cloth. Avoid spinning bearings with air blast, as spinning might damage bearings.

8. Crankcase Bottom Cover. Wash crankcase bottom cover in cleaning solvent. On early model compressors, remove all sediment from sump in bottom of cover.

INSPECTION

1. Cylinder Head. Inspect cylinder head for cracks or breaks. Replace with new head if cracked or damaged.

2. Inlet and Discharge Valve Springs. Discard used inlet and discharge valve springs and replace with new springs.

3. Inlet and Discharge Valves and Seats. Inspect inlet and discharge valves and seats for signs of excessive wear. Replace valves if grooved deeper than 0.003" at point of seat contact. Replace valve seats if condition is such that seats can no longer be refaced.

4. Unloading Pistons and Plungers. Inspect pistons, plungers, and plunger guides for signs of damage or excessive wear. New unloading pistons should slide easily in bores. Check bores for scratches or damage that might increase O-ring wear. Check unloading piston return spring dimension and compare with "Specifications" listed at end of this section. Replace spring if necessary.

5. Crankcase and End Cover. Check crankcase and end cover for cracks or other damage. Replace with new parts if damaged. Check fit of oil seal ring in groove of rear end cover. Ring must be snug fit in groove, and must have 0.008" to 0.015" clearance at gap when placed in end of crankshaft.

6. Crankcase Bearing Bores. On early model compressors, check fit of ball bearings in crankcase bearing bores. Bearings should require a finger press fit. Replace crankcase if bores are worn or damaged.

7. Cylinder Block (Fig. 10). Use telescoping gauge to check bores for out-of-round and taper. Bores which are scored or out-of-round more than 0.002" or tapered more than 0.003" must be rebored, honed, or ground oversize. Pistons and rings 0.010", 0.020", and 0.030" oversize are available. Cylinder bores must be smooth, straight, and round

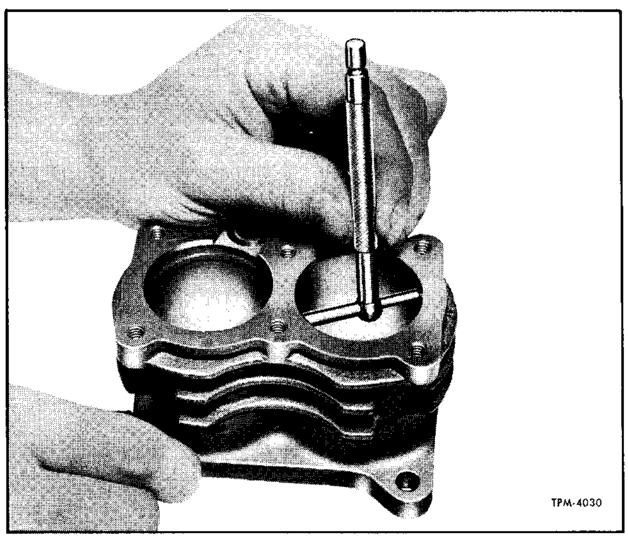


Figure 10—Measuring Cylinder Bore Diameter

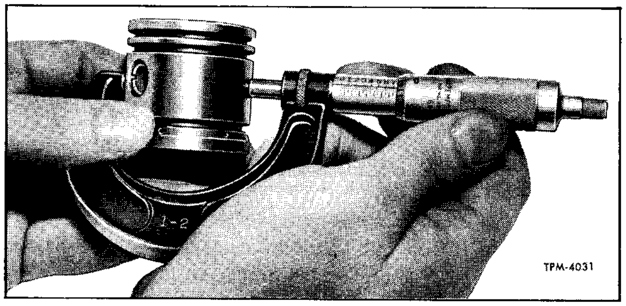


Figure 11—Measuring Piston Diameter

and must be finished with a 500 (or finer) grit hone. The clearance between piston and cylinder wall must not be less than 0.002" or more than 0.004". Replace cylinder block if cracked or damaged.

8. Pistons (Fig. 11). Examine pistons for scoring, cracks, or damage of any kind. Measure outside diameter of piston with a micrometer and compare this measurement with the inside diameter of cylinder bore. Clearance should not be less than 0.002" or more than 0.004". Piston over 0.004" smaller than cylinder bore must be replaced with an oversize piston.

9. Piston Pins and Bushings. Check fit of piston pins in pistons and connecting rods. Pins must be light press fit in pistons. If piston pin is loose in piston, the pin, piston, or both must be replaced. Check fit of piston pins in connecting rod bushings by rocking pins in bushings. If looseness is evident, replace connecting rod bushings as directed under "Compressor Repair." Discard all piston pin lock wires.

10. Piston Rings (Fig. 12). Check fit of piston rings in ring grooves, and check ring gap with ring in cylinder bore. Clearance between rings and

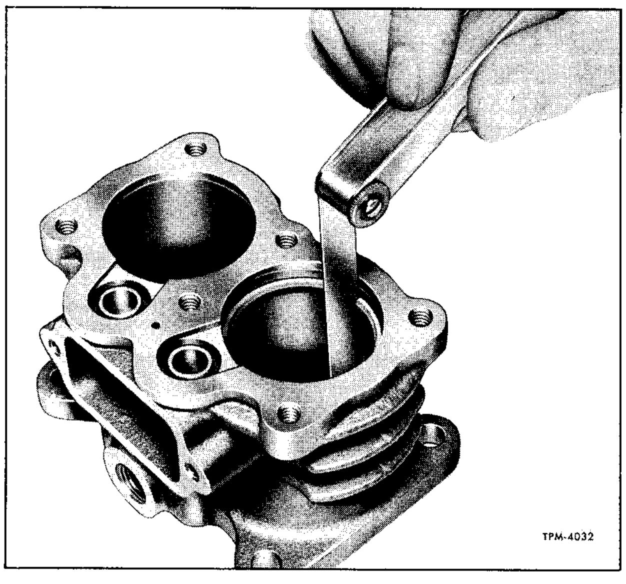


Figure 12—Measuring Piston Ring Gap

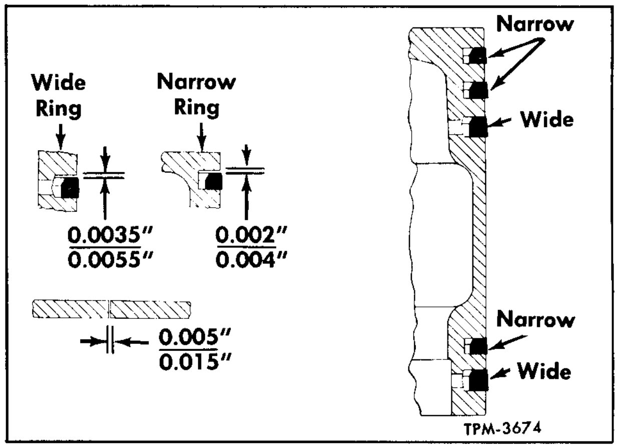


Figure 13—Piston Ring Arrangement and Clearances

sides of ring grooves should be from 0.0035" to 0.0055" for two wide rings and from 0.002" to 0.004" for three narrow rings as shown in figure 13. Ring gap should be from 0.005" to 0.015".

11. Connecting Rods and Bearings. Check fit of connecting rod bearing inserts on crankshaft journals. Clearance between bearings and crankshaft journals must not be less than 0.002" or more than 0.004". Replace bearing inserts if clearance is excessive or if bearings are cracked or flaked. Connecting rod caps are not interchangeable. Position caps so that locking slots are both located adjacent to same cap screw.

12. Crankshaft. Crankshaft journals should not be out-of-round more than 0.001", ridged, or scored. If grinding is necessary, do not grind fillets at ends of journals. Connecting rod bearing inserts are available in 0.010", 0.020", and 0.030" undersize for reground crankshafts. Check main bearing journals for excessive wear. Dimensions should be such that ball bearings are a press fit on journals.

13. Crankshaft Bearings. On early model compressors, examine bearings for wear or flat spots. Replace, if necessary, with new bearings.

14. Crankshaft Bearings. On late model compressors, inspect crankshaft bearings in end cover and crankcase for wear or damage. If necessary replace bearings as described later under "Compressor Repair."

COMPRESSOR REPAIR

DISCHARGE VALVE AND SEATS

1. Remove slight scratches and pits from discharge valve seats. Use lapping stone, grinding compound, lapping disc, and valve grinding tool.

2. Place discharge valve on valve seats, install discharge valve springs in cap nuts, and thread cap nuts firmly into cylinder head. To test discharge valves for leakage, connect air line to discharge port in cylinder head. Apply 100 pounds

air pressure to valves and apply soap suds to discharge valve openings in bottom of cylinder head. Leakage in excess of a one-inch bubble in one second is not permissible. If leakage is excessive, leave air pressure applied. Using a fiber or hardwood dowel and a light hammer, tap valves off seats several times. This should improve fit of valve on seat. Check leakage around top of discharge valve cap nuts by applying soap suds to this area. Leakage must not exceed a one-inch bubble in five seconds. Shut off air pressure and disconnect air line from cylinder head.

3. Remove discharge valve seats too badly worn for refacing. Thread new seats into head and tighten firmly. With new valves, discharge valve travel should be from 0.056" to 0.070".

INLET VALVES AND SEATS

1. Remove slight scratches or pits from inlet valve seats. Use lapping stone, grinding compound, lapping disc, and valve grinding tool. Replace seats that cannot be repaired. Dimension from the top of cylinder block to the inlet valve seat should not exceed 0.145". After installing new seats, the dimension should be 0.101" to 0.113".

2. Inlet valves not badly worn or damaged can be repaired by lapping valves on a piece of crocus cloth held on a flat surface.

CONNECTING ROD BUSHINGS

If piston pin bushings in connecting rods require replacement as previously indicated in step 9 under "Inspection," press old bushings out of connecting rods. Press new bushings in, making sure the oil holes in the bushings line up with the oil passages in the connecting rods. Bushings must then be reamed, honed, or bored to provide 0.0003" -0.0015" clearance on piston pin.

CRANKSHAFT BEARINGS

1. On late model compressors, if crankshaft bearings are worn or damaged, use a suitable puller and remove bearing from end cover.

2. Use a suitable sleeve and press or drive bearing out of crankcase.

3. Using a suitable sleeve, press or drive new bearing into end cover. Press or drive bearing in flush. Use a suitable sleeve and press or drive new bearing in crankcase. Press or drive bearing in flush.

COMPRESSOR ASSEMBLY

CRANKSHAFT INSTALLATION

Key numbers in text refer to figure 8 or 9.

On Early Model Compressors Only (Fig. 8)

1. Press crankshaft rear bearing (8) onto rear end of crankshaft (18), using a bearing driver to exert force on bearing inner race.

2. Insert crankshaft through end cover opening, guiding front end of shaft through front bearing bore in case.

3. Position crankcase and crankshaft in press; then with supports under case to protect rear end cover studs, press on front end of crankshaft until inner edge of rear bearing is flush with inner edge of bearing bore in case.

4. Place crankshaft front bearing (20) over front end of crankshaft. (If shielded bearing is used, shielded side must be up.) Using a suitable bearing sleeve over end of crankshaft, press bearing on crankshaft and into crankcase until bearing bottoms against shoulder in crankcase. Bearing sleeve must be of a size to exert force on both the inner and outer bearing races.

5. Install crankshaft front bearing retainer (19) and attach with three screws. Tighten screws firmly, then stake in place.

6. Install end cover oil seal ring (10) in seal ring groove in crankcase rear end cover (9).

7. Position new end cover gasket (7) over rear end cover studs. Install rear end cover over studs, making sure that seal ring enters bore in rear end of crankshaft. Install stud nuts and tighten firmly.

On Late Model Compressors Only (Fig. 9)

1. Place front thrust washer on crankshaft with oil groove toward shoulder on shaft.

2. Insert crankshaft through end cover opening in crankcase.

3. Position crankcase and crankshaft assembly in a press with rear end up; then press or drive front end of shaft into front bearing.

4. Position rear thrust washer on crankshaft with oil groove toward shoulder on shaft.

5. Install end cover oil seal in groove of end cover.

6. With crankcase and crankshaft assembly positioned in press, with rear end up, place a new gasket on crankcase.

7. Press end cover and bearing assembly on crankshaft until end cover it against the crankcase.

8. Install cap screws and lock washers attaching end cover to crankcase. Tighten cap screws firmly.

On All Air Compressors

Install key in keyway in front end of crankshaft, install drive hub on shaft, and secure with nut and cotter pin.

CYLINDER BLOCK INSTALLATION (Fig. 14)

Place new cylinder block gasket on crankcase. Position cylinder block on crankcase, aligning marks made before disassembly. Install cap screws and lock washers. Tighten cap screws firmly.

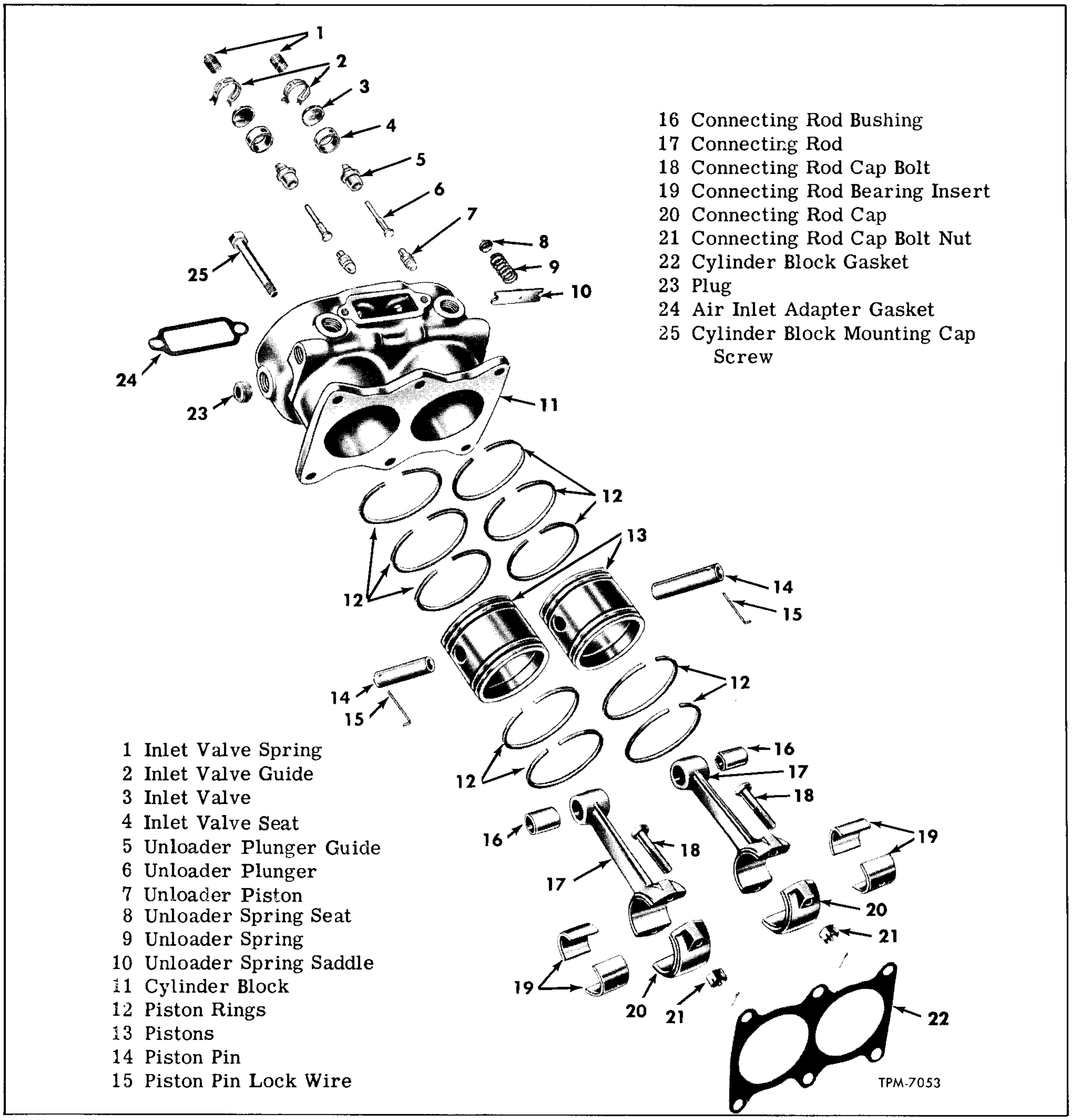


Figure 14—Cylinder Block Components

PISTON AND CONNECTING ROD ASSEMBLY AND INSTALLATION

Key numbers in text refer to figure 14.

1. Position connecting rod (17) in piston (13) and press piston pin (14) into piston (13) with lock wire holes in pin (14) aligned with lock wire holes in piston (13).

2. Install new piston pin lock wire (15) in piston pin (14) so that long end extends through piston and pin. Snap short end into lock wire hole at bottom of piston skirt.

3. Install piston rings (12) in grooves of pistons. Rings must be installed in proper location and with pip marks upward. Refer to figure 13 for proper clearance dimensions and location of rings. Stagger position of ring gaps outside of inlet throat area.

4. Press bearing inserts (19) into rod and cap

(20) by hand, with locking slots in proper alignment (all slots on side of same cap bolt).

5. Lubricate pistons, rings, piston pin bushings, and bearing inserts with clean engine oil.

6. Turn crankshaft to position bearing journal nearest pulley end of crankshaft (No. 1) downward. Remove bearing cap from No. 1 connecting rod leaving connecting rod bolts in rod.

7. Insert No. 1 connecting rod and piston through top of No. 1 cylinder aligning match marks previously installed, and seat squarely on connecting rod bearing journal. Install bearing cap. For proper assembly, two slots in bearing inserts and in rod and cap should be on side of same cap bolt. Install nuts and tighten firmly; then install two new cotter pins.

8. Install No. 2 piston and connecting rod in same manner as described above.

9. Install crankcase bottom cover, using a new gasket, with marks made prior to disassembly aligned. Attach cover to crankcase with screws and lock washers.

10. On early model compressors, make sure oil return tube seals are in place in openings in bottom cover and in mounting flange. Insert oil return tube through hole in mounting flange, and press tube through flange and into bottom cover until it is seated in cover. Make sure seals are not dislodged while pressing tube into place.

UNLOADER PISTON AND PLUNGER ASSEMBLY AND INSTALLATION (Figs. 7 and 9)

1. Coat each unloader piston, O-ring, and piston bore with a silicone type lubricant. Insert piston in bore.

2. Insert plunger in plunger guide. Hold guide and plunger with large-nose pliers and install over unloader piston.

3. Install unloader spring saddle and unloader spring. Make certain that saddle rests squarely on top of plunger guides and make sure top of spring engages spring seat pressed into block.

CYLINDER HEAD ASSEMBLY AND INSTALLATION (Fig. 15)

1. Install discharge valve seats in cylinder head. Place discharge valves on seats through opening in top of cylinder head. Place discharge valve springs in discharge valve cap nuts. Thread cap nuts into cylinder head. Tighten nuts firmly.

2. Place inlet valves (3, fig. 14), inlet valve guides (2, fig. 14), and inlet valve springs (1, fig. 14) in bores in top of cylinder block.

3. Install new cylinder head gasket on cylinder block. Carefully align inlet valve springs with inlet valve guides in cylinder head. Align marks made before disassembly and install cylinder head on cylinder block. Install cylinder head cap screws

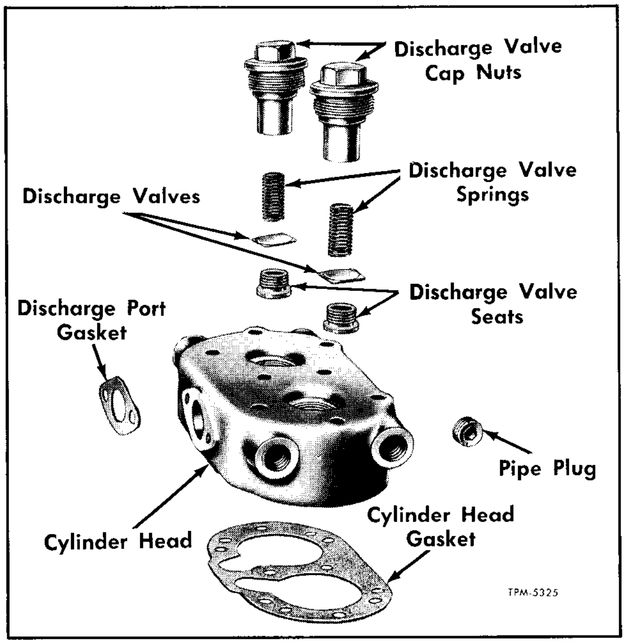


Figure 15—Cylinder Head Components

and tighten evenly and firmly. Replace all pipe plugs.

4. Install new gasket and replace air inlet elbow.

AIR COMPRESSOR TESTS AFTER OVERHAUL

After overhauling the air compressor, following tests are recommended to determine if compressor is operating properly. Connect an oil supply line, having at least 15 pounds pressure to compressor rear end cover opening. Plug other opening in end cover and in crankcase. Provisions must be made for drainage of oil from crankcase during test. Water must be circulated through compressor water passages while compressor is operating. Figure 16 shows a typical test hook-up which can be used to make the following tests.

RUN-IN TEST

Run compressor for one-half hour at 1750 rpm with compressor discharge port open to atmosphere. Check for oil leaks, overheated bearings, and excessive noise.

OIL PASSING TEST

Run compressor for one-half hour at 1750 rpm, pumping against 50 psi air pressure with an oil trap connected in the discharge line (fig. 16). Close valves 2 and 4, open valve 1, and adjust pressure regulating valve to maintain 50 psi air pressure in the reservoir. Cover air inlet opening in compressor intake cavity with a plate drilled at center to a

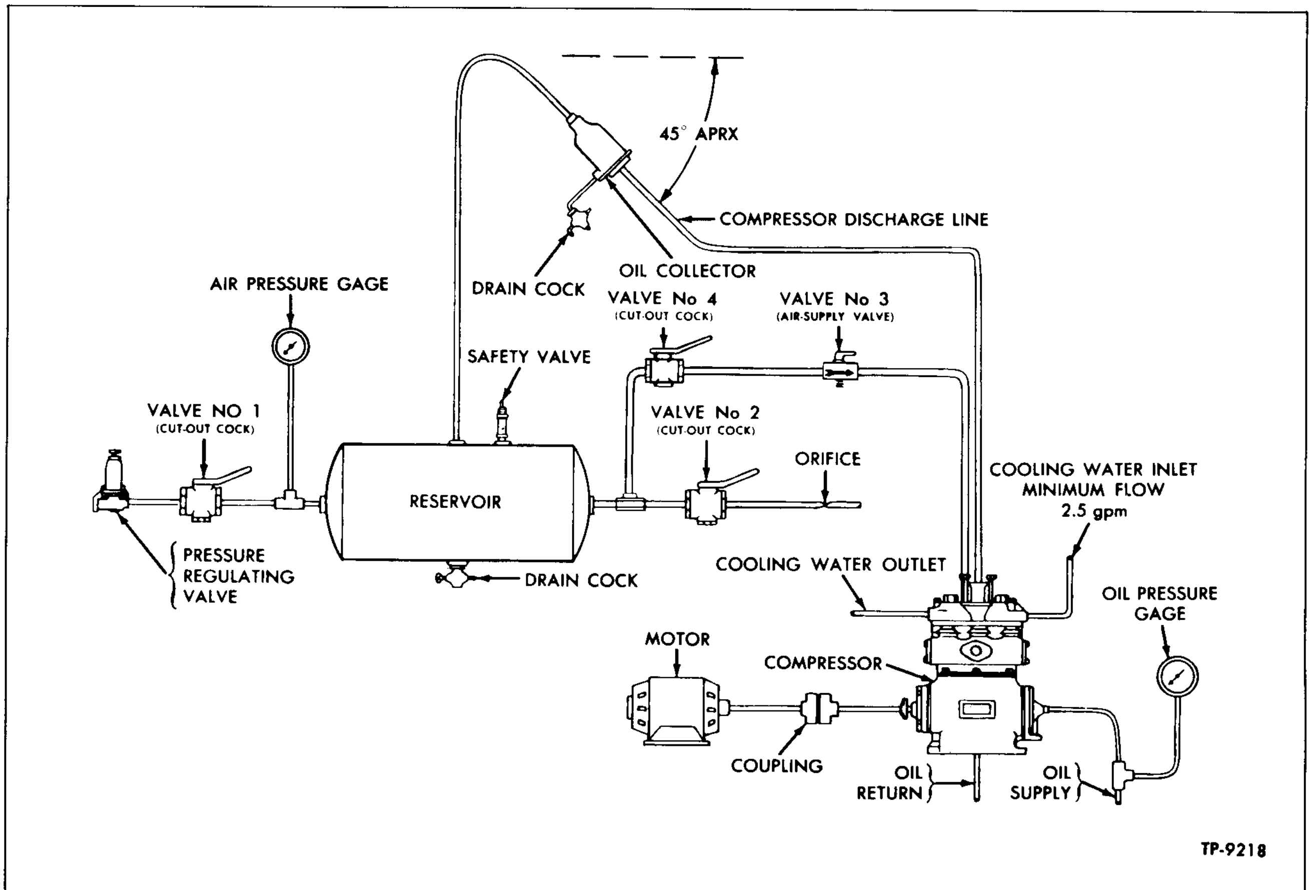


Figure 16—Typical Air Compressor Test Hook-Up

3/8" orifice. Drain the oil collector completely before starting test. At end of half hour test, stop motor and open reservoir drain cock to drain air pressure completely. Open oil collector drain cock to collect and measure oil passed. The oil passed during this test must not exceed 2 cubic centimeters.

EFFICIENCY TEST

This test is made by running compressor one-half hour at 1750 rpm connected to a reservoir fitted with an orifice type exhaust fitting. Close valves 1 and 4 (fig. 16), open valve 2, and mount orifice in line beyond valve 2. Orifice should be 0.089". With air exhausting continuously through orifice, compressor should maintain 75 psi pressure in reservoir.

This test can also be used on a compressor before it is overhauled to determine the necessity of an overhaul. A compressor which does not maintain 60 pounds pressure in reservoir at 1750 rpm should be overhauled.

COMPRESSOR UNLOADER MECHANISM TEST

The compressor unloader can be tested by closing valves 1 and 2 and opening valves 3 and 4 (fig. 16). Run compressor until unloader operates. Watch air pressure. Unloader should operate at 115 to 120 psi, stopping further compression.

UNLOADER PISTON TEST

Unloader piston should be tested by application of 115 psi air pressure through governor line port. When coating unloader pistons with soap suds, leakage should not exceed a 1/2" soap bubble in less than five seconds.

AIR COMPRESSOR GOVERNOR—TYPE "D"

Air compressor governor, acting in conjunction with the compressor unloading mechanism, automatically limits air tank pressure to a preset range. Unloading valves open to stop compression when air pressure is built up to high limit (115-120 psi). Unloading valves close to start compression when air pressure drops to low limit (100-105 psi).

Governor consists essentially of a diaphragm

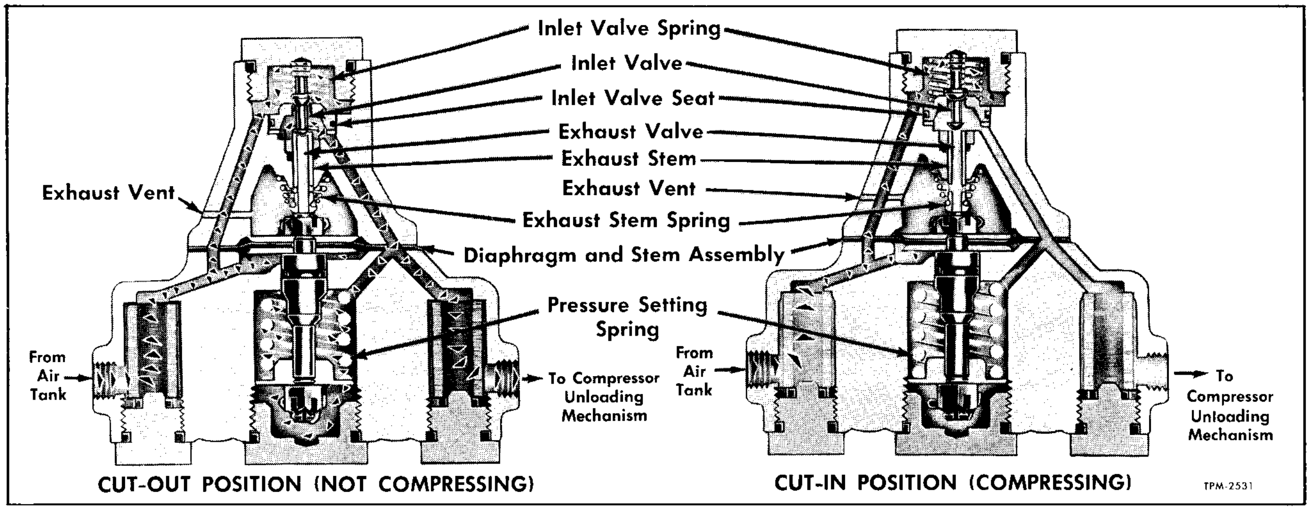


Figure 17—Air Compressor Governor Operation (Type "D")

upon which air pressure acts, a spring to control movement of the diaphragm assembly, and a valve mechanism controlled by position of the diaphragm assembly, which admits air to, or exhausts air from the unloading mechanism in compressor cylinder head.

GOVERNOR OPERATION (Fig. 17)

Compressed air from air tank enters the governor at port marked "RES" and passes through strainer. This air pressure is always present above the inlet valve and on one side of the diaphragm.

Cutting Out. As pressure increases, diaphragm and stem assembly moves up against resistance of the pressure setting spring. By the time tank pressure reaches cut-out point (115-120), the diaphragm has moved far enough to seat exhaust valve and to open inlet valve. When inlet valve opens, tank air flows past inlet valve and out port marked "UNL" to compressor unloading mechanism. Air pressure opens the unloading valves and stops compression. With inlet valve open, air also flows through passages in the body to the cavity containing pressure setting spring. Acting on the area of the stem, pressure increases effective force on the diaphragm. This further compresses pressure setting spring and fully opens the inlet valve.

Cutting In. As air tank pressure drops to the governor cut-in point (100-105 psi), pressure acting on diaphragm is reduced. Pressure setting spring expands, moving the diaphragm and stem assembly downward. The inlet valve closes as exhaust valve opens. Unloader air escapes past open exhaust valve, on through hollow exhaust stem, and out exhaust vent in valve body. As air escapes, inlet valves in compressor cylinder block close. Air also escapes from pressure setting spring cavity. This further reduces pressure behind diaphragm and stem assembly. Exhaust valve opens rapidly and completely. Compressor resumes air tank pressure build-up.

GOVERNOR TESTS (Fig. 18)

Operating Test

With engine running, build up air pressure in system. Observe reading on air pressure gauge in gauge panel when governor cuts out, stopping further compression. Gauge reading when governor cuts out should be between 115 and 120 psi.

With engine still running, slowly reduce air pressure in system by applying and releasing brakes. Observe pressure registered by gauge when governor cuts in and compression is resumed. Gauge reading when governor cuts in should be

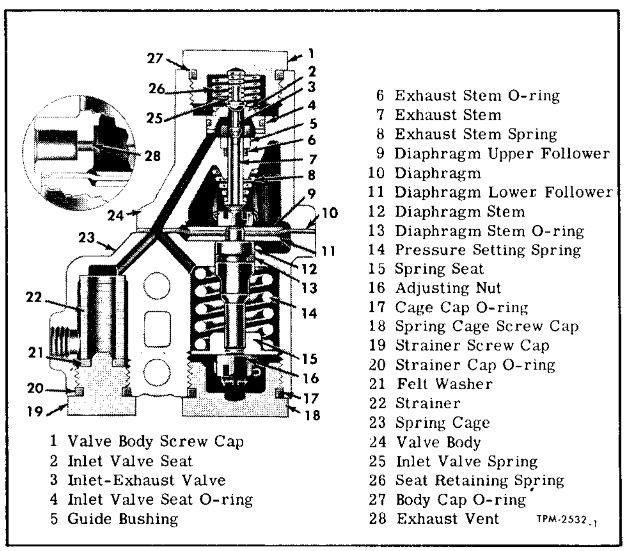
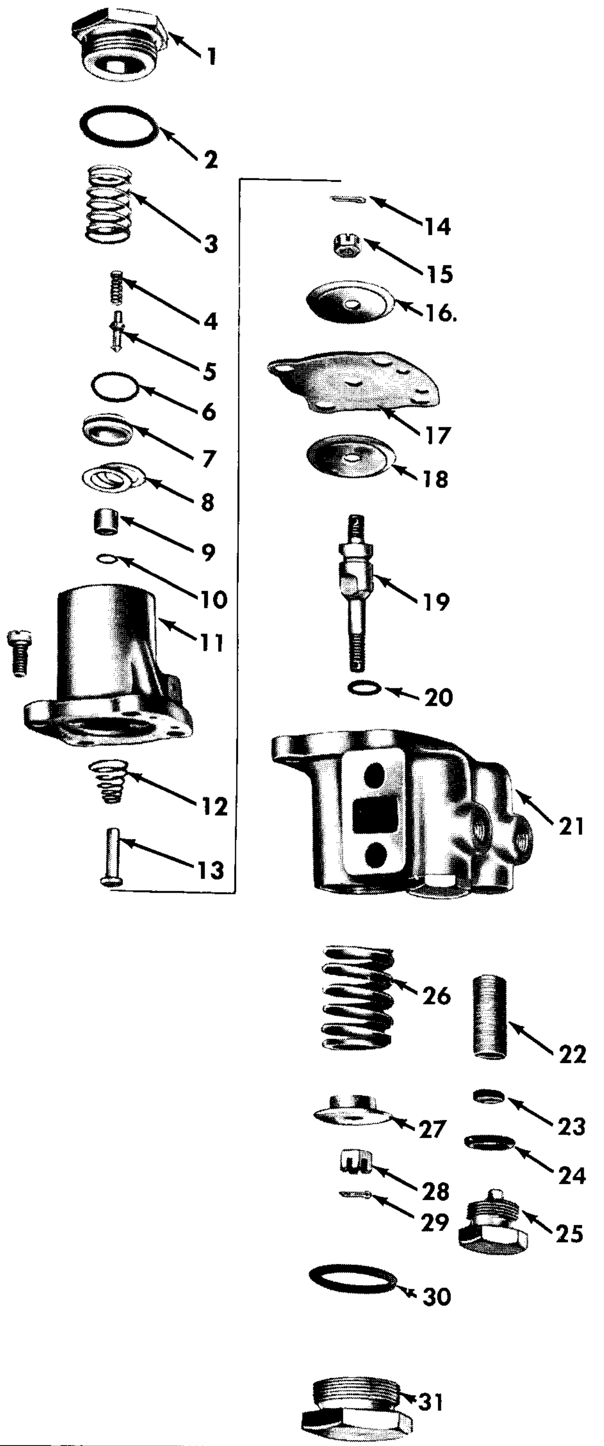


Figure 18—Air Compressor Governor (Type "D")

AIR COMP. AND GOVERNOR (B-W)



1 Valve Body Screw Cap
2 Body Cap O-ring
3 Seat Retaining Spring
4 Inlet Valve Spring
5 Inlet-Exhaust Valve
6 Inlet Valve Seat O-ring
7 Inlet Valve Seat
8 Shims
9 Guide Bushing
10 Exhaust Stem O-ring
11 Valve Body
12 Exhaust Stem Spring
13 Exhaust Stem
14 Cotter Pin
15 Nut
16 Diaphragm Upper Follower
17 Diaphragm
18 Diaphragm Lower Follower
19 Diaphragm Stem
20 Diaphragm Stem O-ring
21 Spring Cage
22 Strainer
23 Felt Washer
24 Strainer Cap O-ring
25 Strainer Screw Cap
26 Pressure Setting Spring
27 Spring Seat
28 Adjusting Nut
29 Cotter Pin
30 Cage Cap O-ring
31 Spring Cage Screw Cap

TPM-2533-1

Figure 19—Type "D" Governor Components

between 100 and 105 psi.

Before condemning or adjusting the governor, be sure the dash gauge is registering accurately. Use an accurate test gauge to check the pressure registered by the dash gauge.

Leakage Test

With governor in "cut-out" position, test for leakage at exhaust valve by applying soap suds to exhaust vent in valve body.

With governor in "cut-in" position, test for

leakage at the inlet valve by applying soap suds to exhaust vent in valve body.

Leakage in excess of a 1-inch soap bubble in three seconds is not permissible in either of the above tests.

Coat the entire governor with soap suds to detect diaphragm, gasket, and cap screw leakage. No leakage is permissible.

GOVERNOR ADJUSTMENT

If necessary to adjust governor settings, remove spring cage screw cap; then remove cotter pin from diaphragm stem and adjusting nut. Pressure settings are raised by turning adjusting nut clockwise, and lowered by turning adjusting nut counterclockwise. Cotter pin must be replaced after adjustment. The range between the cut-out and cut-in setting is fixed at approximately 15 psi and cannot be adjusted.

GOVERNOR REPLACEMENT

REMOVAL

1. Block coach and apply hand brake.
2. Exhaust all air pressure from the air system.
3. Disconnect air lines from the governor.
4. Remove bolts and lock washers attaching governor to the air compressor.
5. Remove governor and governor to air compressor gasket. Discard gasket.

INSTALLATION

1. Clean mounting pad on both compressor and governor. Clean connecting line, or lines. Also be sure compressor unloading port is clean.
2. Position governor and new gasket on air compressor. Install attaching bolts and lock washers. Tighten bolts firmly.
3. Reconnect air line, or lines. Tighten fittings securely.
4. Build up air pressure in the system. Test governor as described previously under "Governor Tests."

TYPE "D" GOVERNOR OVERHAUL

DISASSEMBLY

NOTE: Key numbers in text refer to figure 19.

1. Remove dirt and grease from outside of the governor, using a brush and cleaning solvent.
2. Remove valve body screw cap (1); then remove inlet valve spring (4), seat retaining spring (3), and inlet-exhaust valve (5). Remove O-ring (2) from screw cap.
3. Remove inlet valve seat (7), being careful not to damage inlet valve seating surface. Remove shims (8) from inlet valve seat bore in body. Remove O-ring (6) from valve seat.
4. Remove spring cage screw cap (31). Remove O-ring (30) from cap. Remove cotter pin (29) and adjusting nut (28) from diaphragm stem (19). Remove spring seat (27) and pressure setting spring (26).
5. Remove four cap screws attaching valve body (11) to spring cage (21). Separate valve body from spring cage. Remove exhaust stem (13) and spring (12) from body.
6. Remove diaphragm and stem assembly from spring cage. Remove cotter pin (14) and nut (15) from top of diaphragm stem, then remove diaphragm (17) and diaphragm followers (16 and 18) from diaphragm stem. Remove O-ring (20) from diaphragm stem.
7. Using a hooked tool, remove O-ring (10) from groove between guide bushing (9) and bore in valve body.
8. Remove two strainer screw caps (25), O-rings (24), felt washer (23), and strainers (22) from spring cage. Discard diaphragm, felt washers, and O-rings.

CLEANING AND INSPECTION

NOTE: Key numbers in text refer to figure 19.

1. Clean all parts in cleaning solvent, making sure all air passages through valve body, spring cage, and exhaust stem are not obstructed in any way. Make sure air strainers (22) are thoroughly cleaned.
2. Inspect both seats on the inlet-exhaust valve (5) for grooves or damage. If either seat is grooved or damaged, replace inlet-exhaust valve.
3. Inspect inlet valve seat (7) for wear or damage. Replace seat if worn or damaged.
4. Inspect seat in upper end of exhaust stem (13). Replace stem if seat is worn or damaged. Also check fit of exhaust stem in valve body (11). Stem should be a neat sliding fit in body. Replace stem if excessively loose.

ASSEMBLY

NOTE: Key numbers in text refer to figure 19. Refer to figure 18 for assembled view.

Apply thin coat of grease containing zinc oxide (#1) to exhaust stem, diaphragm stem, and all O-rings.

1. Install new exhaust stem O-ring (10) in groove between guide bushing (9) and bore in valve body (11). Install exhaust stem spring (12) and exhaust stem (13) in body, being sure stem is a neat sliding fit in body.
2. Assemble diaphragm lower follower (18), diaphragm (17), and upper follower (16) on diaphragm stem (19), making sure beveled side of both followers are toward diaphragm. Install nut (15), tighten to 10-15 inch-pounds torque, and secure with cotter pin (14). Bend both legs of cotter pin toward the diaphragm.

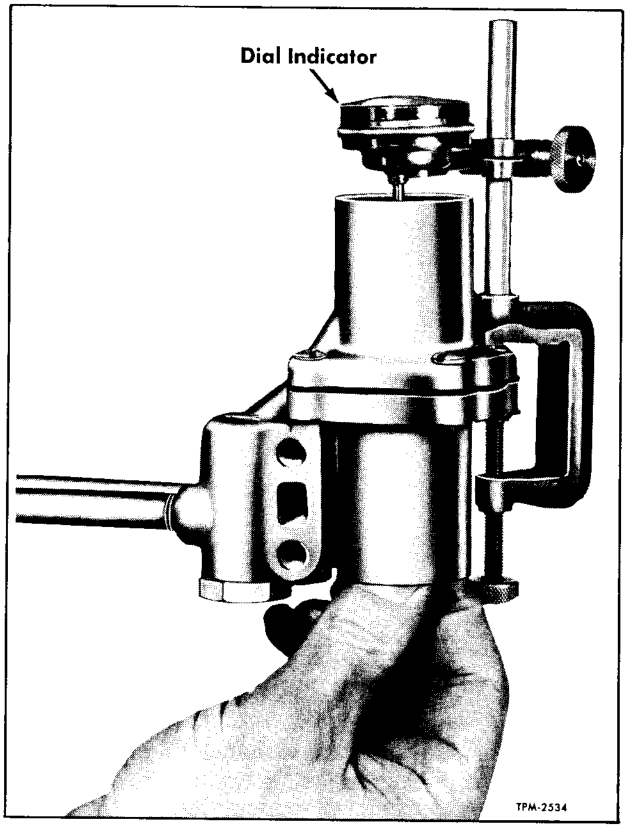


Figure 20—Checking Governor Valve Travel

3. Install new O-ring (20) in groove in diaphragm stem (19). Install diaphragm and stem in spring cage (21), making sure stem is a neat sliding fit in bore in spring cage.

4. Assemble valve body on diaphragm and spring cage, making sure all air passages are aligned, and secure with four cap screws.

5. Install strainers (22), felt washers (23), and strainer screw caps (25) in bottom of spring cage, using new strainer cap O-rings (24) in grooves in screw caps. Tighten screw caps firmly.

6. Measure total valve travel (fig. 20) by pulling diaphragm stem down as far as possible and setting dial indicator at zero when contacting top of exhaust stem. Push diaphragm stem completely in and read total valve travel on dial indicator. Total travel should be 0.060" to 0.098".

7. Install new O-ring (6) in groove on inlet valve seat (7), then install inlet valve seat and inlet-exhaust valve. Repeat the above check starting with the indicator zeroed on end of inlet-exhaust valve. Add or remove shims (8) under inlet valve seat until valve travel is within 0.030" to 0.040".

8. Install inlet valve seat retaining spring (3) and inlet valve spring (4). Install new O-ring (2) on valve body screw cap (1) and thread screw cap into valve body. Tighten screw cap firmly.

9. Install pressure setting spring (26) and spring seat (27) on diaphragm stem in spring cage and secure with adjusting nut (28).

10. Mount governor on suitable test rack or on vehicle and connect air pressure source to port marked "RES." Leave spring cage screw cap (31) removed.

11. Build up pressure from zero and note pressure at which air starts to escape from spring cage. If less than 115 psi, turn adjusting nut clockwise; if above 120 psi, turn adjusting nut counterclockwise. After final adjustment, leakage should start at 115-120 psi. Secure adjusting nut (28) with cotter pin (29).

12. Install new O-ring (30) in groove in spring cage screw cap (31) and thread cap into spring cage. Tighten firmly.

AIR COMPRESSOR GOVERNOR—TYPE "D-2"

DESCRIPTION

The governor, operating in conjunction with air compressor unloading mechanism, automatically controls air pressure in the air brake or air supply system between the desired, predetermined maximum, and minimum pressures. The air compressor runs continually while the engine runs, but actual compression of air is controlled by the governor which stops or starts compression when the maximum or minimum reservoir pressures are reached. The "D-2" governor has a piston upon which air pressure acts to overcome the pressure setting spring and control the inlet and exhaust valve to either admit or exhaust air to or from air compressor unloading mechanism.

Type "D-2" governors can be attached to the air compressor or mounted remotely. They are adaptable to either mounting. Connections in this system are to the reservoir and compressor unloading ports. They also have an exhaust port (fig. 21).

OPERATION

(Refer to Figure 22)

Reservoir air pressure enters the D-2 governor at one of its reservoir ports and acts on the area of the piston and beneath the inlet and exhaust valve. As air pressure builds up the piston moves against resistance of the pressure setting spring. The piston and inlet exhaust valve move up when reservoir air pressure reaches cut-out setting of the governor. The exhaust stem seats on the inlet and exhaust valve and then the inlet passage opens. Reservoir air pressure then flows by the open inlet valve, through the passage in piston and out

unloader port to the compressor unloading mechanism. The air, besides flowing to compressor unloading mechanism, also flows around the piston and acts on additional area of the piston. This additive force which results from a larger area on the piston assures a positive action and fully opens the inlet valve.

As the system reservoir air pressure drops to the cut-in setting of the governor, force exerted by the air pressure on the piston will be reduced so that the pressure setting spring will move the piston down. The inlet valve will close and exhaust will open. With exhaust open, air in the unloader line will escape back through the piston, through the exhaust stem and out the exhaust port.

MAINTENANCE

Every 500 operating hours or after every 15,000 miles, clean or replace governor filters (fig. 22). Clean or replace filters as described later in this section under "Type "D-2" Governor Overhaul."

Every 3,000 operating hours or after every 100,000 miles, disassemble the "D-2" governor and clean and inspect all parts. Repair governor as described later in this section under "Type "D-2" Governor Overhaul."

GOVERNOR TESTS

OPERATING TEST (Fig. 22)

Start the engine and build up air pressure in system. Observe reading on air pressure gauge in gauge panel when governor cuts-out, stopping compression of air by the compressor. Reading on gauge when governor cuts-out should be between 115 and 120 psi.

With the engine still running, slowly reduce air pressure in the system by applying and releasing brakes. Observe pressure registered by gauge when governor cuts-in and compression is resumed. Gauge reading when governor cuts-in should be between 100 and 105 psi.

Before condemning or adjusting the governor, be sure the dash air gauge is registering accurately. Use an accurate test gauge to check pressure registered by the dash gauge. If the pressure settings of the Type "D-2" governor are inaccurate or it is necessary that they be changed, adjust governor as described in the following:

ADJUSTMENT

1. Unscrew cover at top of the governor.
2. Loosen adjusting screw lock nut.
3. Using a screwdriver, turn adjusting screw counterclockwise to raise pressure settings. Turn adjusting screw clockwise to lower the pressure settings.

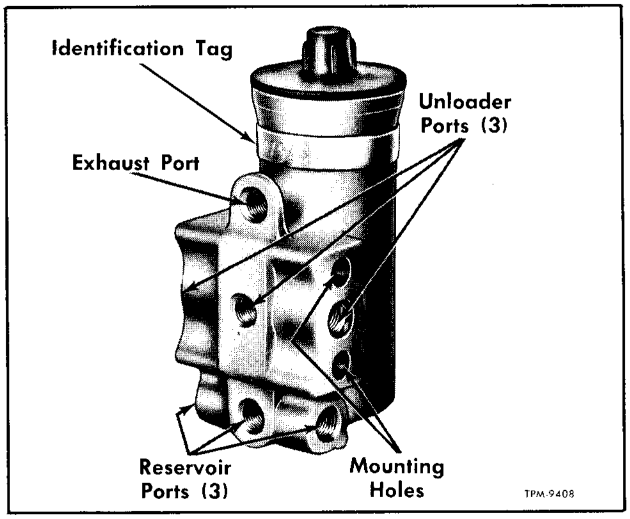


Figure 21—Type "D-2" Governor Ports

4. When adjustment is completed, tighten adjusting screw lock nut.
5. Install cover on the governor.

LEAKAGE TEST

Leakage checks on the "D-2" governor are made at its exhaust port in both cut-in and cut-out positions. In the cut-in position, check exhaust port for inlet valve leakage by applying a soap solution at the port. Leakage could also be past the bottom piston grommet. In the cut-out position check the exhaust port to determine if leakage is present at the exhaust valve seat or stem grommet. In this position leakage could also be past the upper piston grommet.

Leakage in excess of a 1-inch soap bubble in

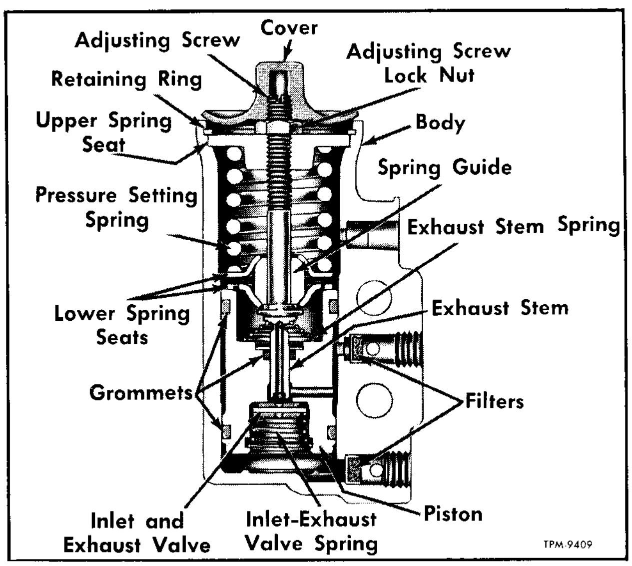


Figure 22—Type "D-2" Air Compressor Governor

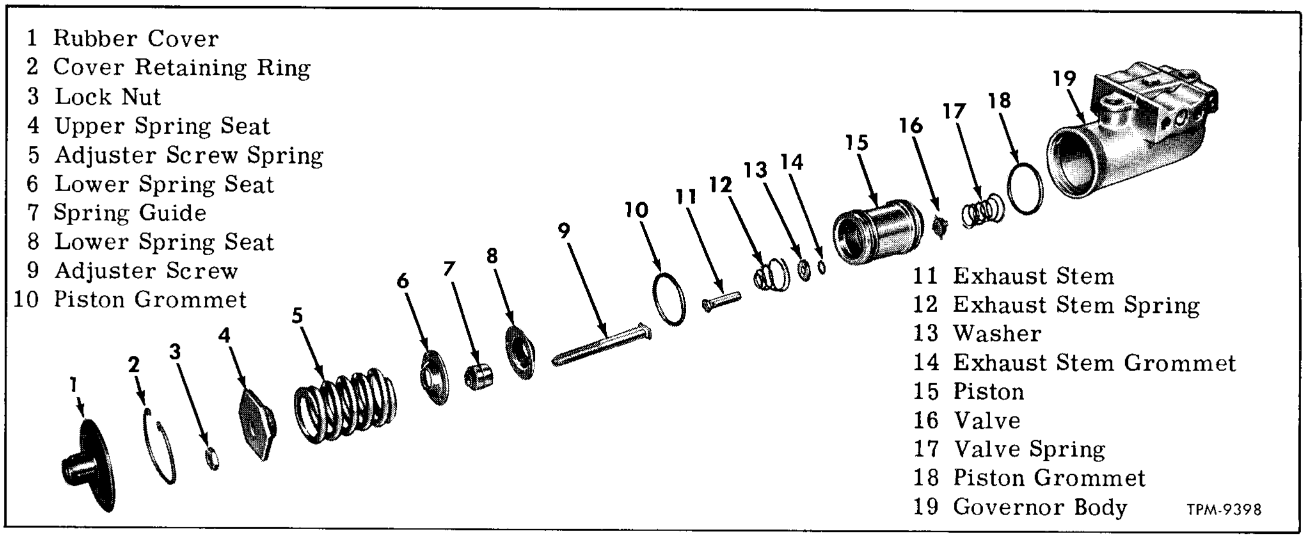


Figure 23—Type "D-2" Governor Components

three seconds is not permissible in either of the above tests. Overhaul governor as described below under "Type "D-2" Governor Overhaul."

TYPE "D-2" GOVERNOR OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 23.

1. Using cleaning solvent and a brush, clean dirt and grease from exterior of governor.

2. Using fingers, remove rubber cover (1) from governor assembly. Remove two pipe plugs from governor body.

3. Using Tru-Arc pliers, remove cover retaining ring (2) from groove in governor body (19).

4. Remove adjusting screw and spring assembly from governor body (19).

5. Remove the piston assembly from governor body. It may be necessary to tap governor body flat against work bench to dislodge piston.

6. Remove two piston grommets (10 and 18) from grooves in piston (15). Discard grommets.

7. Remove valve spring (17), valve (16), exhaust stem (11), and exhaust stem spring (12) from piston (15).

8. Remove exhaust stem grommet (14) and washer (13) from bore. Discard grommet.

9. Mount adjusting screw and spring assembly in a vise with soft jaws.

10. Carefully measure distance lock nut (3) is threaded on adjuster screw (9) before removing it in step 11 following:

11. Remove lock nut (3) from adjuster screw; then thread adjuster screw (9) out of upper spring seat (4).

12. Remove spring (5), lower spring seat (6), spring guide (7), and second lower spring seat (8) from adjuster screw.

CLEANING AND INSPECTION

1. Wash all metal parts in cleaning solvent. Blow parts dry. Wipe rubber parts dry.

2. Check valve spring (17), exhaust stem spring (12), and adjuster screw spring (5) for free length, compressed length, distortion, or collapsed coils.

3. Inspect governor body (19) for cracks, nicks, burrs, or other damage. Check for crossed or stripped threads.

4. Inspect adjuster screw (9) for crossed or stripped threads and distortion.

5. Examine the piston (15) for nicks, burrs, or other damage.

6. Check governor valve (16) for deterioration or other damage.

7. Examine the two filters in governor body. If damaged, use a sharp hooked tool and remove them. Use a suitable sleeve and press new filters in governor body ports.

8. Inspect all air passages in ports for obstructions.

ASSEMBLY

Key numbers in text refer to figure 23.

Prior to assembly of governor, lubricate governor body bore, top of piston, piston grooves, piston grommets, spring guide, and adjusting screw with grease containing zinc oxide (#1).

1. Position first lower spring seat (8), spring guide (7), second lower spring seat (6), and spring (5) on adjuster screw (9).

2. Thread adjuster screw (9) into upper spring seat (4); then mount adjuster screw and spring assembly in a vise having soft jaws.

3. Install lock nut (3) on adjuster screw (9). Turn nut on screw the same distance measured at

disassembly.

4. Position new exhaust stem grommet (14) in groove inside piston (15). Install new washer (13) in piston (15). Prick punch washer in four places.

5. Install two new grommets (10 and 18) in grooves on outside of piston (15).

6. Position exhaust stem spring (12), exhaust stem (11), valve (16), and valve spring (17) in piston.

7. Insert piston assembly in bore of governor body.

8. Position adjusting screw and spring assembly in governor body; then using Tru-Arc pliers install the retaining ring (2).

9. Install new rubber cover (1) on governor body (19) over adjusting screw (9).

10. If previously removed, install two pipe plugs in governor body.

11. After the governor is installed in the vehicle, make "Governor Tests" described previously.

Refer to next page for "Specifications."

AIR COMP. AND GOVERNOR (B-W)

SPECIFICATIONS

AIR COMPRESSOR

MAKE	Bendix-Westinghouse
MODEL	Tu-Flo 500
TYPE	2 Cylinder, Water Cooled, Engine Oil Lubricated, and Flange Mounted
CAPACITY (AT 1250 RPM)	12 Cu. Ft.
CYLINDER BLOCK BORE	2.5005″
INLET VALVE SEAT WORN GROOVE	
Not to Exceed	0.003″
DISCHARGE VALVE SEAT WORN GROOVE	
Not to Exceed	0.003″
PISTON RING GAP (IN CYLINDER)	0.005″-0.015″
PISTON RING CLEARANCE (IN GROOVE)	
Narrow Ring	0.002″-0.004″
Wide Ring	0.0035″-0.0055″
CLEARANCE BETWEEN PISTON AND CYLINDER WALL	0.002″-0.004″
PISTON	
Length	2.4970″
Number Ring Grooves	$2\frac{11}{32}$″
Width of Ring Grooves	0.0960″-0.0965″
WRIST PIN	
Length	$2\frac{5}{16}$″
Inside Diameter	$\frac{5}{16}$″
Outside Diameter	0.4375″-0.4377″
BUSHINGS	
Cylinder Block Bushing	
Outside Diameter	0.473″-0.474″
Inside Diameter	0.376″-0.378″
Width	0.690″-0.693″
Wrist Pin Bushing	
Outside Diameter	0.6570″-0.6575″
Inside Diameter	0.508″-0.510″
Width	0.845″
CRANKSHAFT BEARINGS (EARLY TYPE)	
Front	
Outside Diameter	2.84341″-2.84346″
Inside Diameter	1.3775″-1.3780″
Width	0.6688″-0.6693″
Number of Balls	12
Size of Balls	$\frac{7}{16}$″
Type	Single Row Ball
Rear	
Outside Diameter	3.5427″-3.5433″
Inside Diameter	2.1648″-2.1654″
Width	0.7082″-0.7087″
Number of Balls	13
Size of Balls	$\frac{13}{32}$″
Type	Single Row Ball
CRANKSHAFT BUSHINGS (LATE TYPE)	
Front	
Outside Diameter	1.5040″-1.5055″
Inside Diameter	1.3807″-1.3813″
Width	0.531″-0.541″
Rear	
Outside Diameter	2.2980″-2.2995″
Inside Diameter	2.1684″-2.1689″
Width	0.552″-0.572″
CRANKSHAFT	
Front Bearing Journal Diameter	1.3779″-1.3783″
Connecting Rod Journal Diameter	1.1242″-1.1250″
Rear Bearing Journal Diameter	2.1653″-2.1658″
Length	$8\frac{47}{64}$″
CONNECTING ROD BEARING INSERT	
Width	1.235″-1.250″
Wall Thickness—Standard	0.05185″-0.05210″
0.010″ Undersize	0.05685″-0.05710″
0.020″ Undersize	0.06185″-0.06210″
0.030″ Undersize	0.06685″-0.06710″
Length	0.924″
CRANKSHAFT THRUST WASHER (LATE TYPE ONLY)	
Front	
Inside Diameter	1.476″
Outside Diameter	1.976″
Thickness	0.062″-0.063″
Rear	
Inside Diameter	2.263″
Outside Diameter	2.763″
Thickness	0.062″-0.063″
SPRINGS	
Unloader Spring	
Free Length	$\frac{3}{4}$″
Solid Length	$\frac{5}{16}$″
No. of Active Coils	5
Discharge Valve Spring	
Free Length	$1\frac{7}{64}$″
Solid Length	$\frac{13}{16}$″
No. of Active Coils	13
Inlet Valve Spring	
Free Length	$\frac{29}{64}$″
Solid Length	$\frac{13}{64}$″
No. of Active Coils	6

GOVERNOR

MAKE	Bendix-Westinghouse
MODEL	
Early	"D"
Late	"D-2"
CUT-OUT PRESSURE	115-120 PSI
CUT-IN PRESSURE	100-105 PSI
SPRINGS	
Seat Retaining Spring (Type—"D")	
Free Length	$1\frac{5}{64}$″
Solid Length	$\frac{7}{16}$″
No. of Active Coils	5
Inlet Valve Spring (Type—"D")	
Free Length	$\frac{17}{32}$″
Solid Length	$\frac{13}{64}$″
No. of Active Coils	7
Graduating Spring (Type—"D")	
Free Length	$1\frac{25}{64}$″
Solid Length	$\frac{15}{16}$″
No. of Active Coils	4
Exhaust Stem Spring (Type—"D")	
Free Length	$\frac{45}{64}$″
Solid Length	$\frac{15}{64}$″
No. of Active Coils	5
Valve Spring (Type—"D-2")	
Free Length	$\frac{53}{64}$″
Solid Length	$\frac{5}{32}$″
No. of Active Coils	4
Exhaust Stem Spring (Type—"D-2")	
Free Length	$\frac{19}{32}$″
Solid Length	$\frac{3}{64}$″
No. of Active Coils	3
Adjuster Screw Spring	
Free Length	$1\frac{23}{32}$″
Solid Length	$1\frac{1}{64}$″
No. of Active Coils	$4\frac{1}{2}$

Air Compressor and Governor
(MIDLAND-ROSS)

AIR COMPRESSOR

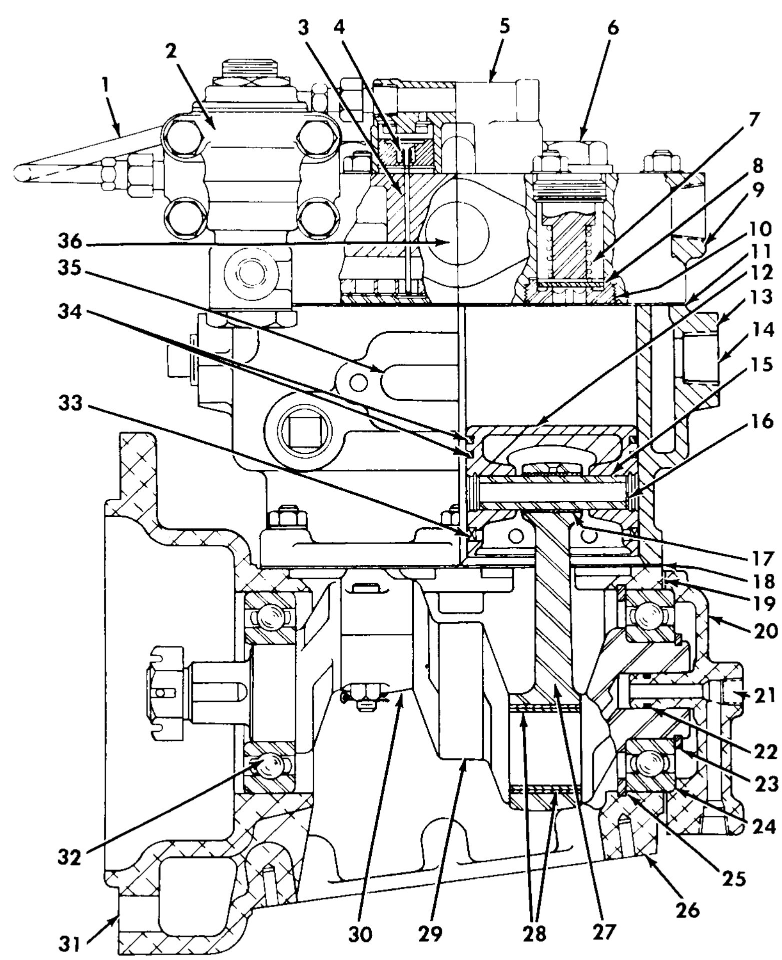
DESCRIPTION

The air compressor (fig. 1) is a two-cylinder, single acting reciprocating type unit. Compressor is flanged mounted to gear train cover at rear end of engine. Drive is direct from camshaft and lubrication is supplied by engine lubrication system. The cylinder block and the cylinder head are cooled by engine cooling system. Compressor has a rated capacity of 12 cubic feet of air per minute. This rating is based on piston displacement at 1250 rpm.

Compressor governor, bracket mounted to top of compressor cylinder head, controls compression of air. Crankshaft is mounted in two ball bearing assemblies. Connecting rod bearings are replaceable half type. Upper ends of connecting rods are equipped with replaceable bushings. Each piston has two compression rings at top and one oil ring at bottom. Piston pins are held in pistons with snap rings at both ends of piston pin.

COMPRESSOR DRIVE AND LUBRICATION

A hub with internal fiber teeth is keyed to the front end of the compressor crankshaft and secured by a nut and cotter pin. An internal-toothed



1 Governor to Unloader Tube
2 Governor Assembly
3 Inlet Valve Plunger
4 Plunger Spring
5 Unloader Assembly
6 Discharge Valve Cap Nut
7 Discharge Valve Spring
8 Discharge Valve
9 Cylinder Head
10 Discharge Valve Seat
11 Cylinder Head Gasket
12 Piston
13 Cylinder Block
14 Water Inlet
15 Piston Pin
16 Piston Pin Lock Ring
17 Connecting Rod Bushing
18 Cylinder Block Gasket
19 Bearing Cap Gasket
20 Rear Bearing Cap
21 Oil Inlet
22 O-ring Seal
23 Bearing Lock Ring (Small)
24 Crankshaft Rear Bearing
25 Bearing Lock Ring (Large)
26 Crankcase
27 Connecting Rod
28 Rod Bearing Halves
29 Crankshaft
30 Rod Bearing Cap
31 Oil Outlet
32 Crankshaft Front Bearing
33 Oil Ring
34 Compression Rings
35 Air Inlet Port
36 Air Discharge Port

TPM-8750

Figure 1—Air Compressor and Governor (Midland-Ross)

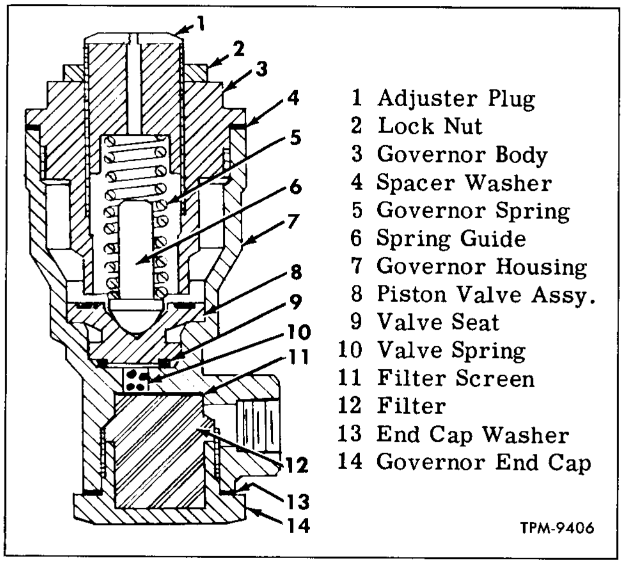


Figure 2—Air Compressor Governor

fiber drive disc is attached to the engine camshaft gear by four cap screws. A drive coupling with external teeth at each end is carried in the internal teeth of the hub and drive disc, transmitting power from drive disc to air compressor crankshaft hub.

Oil, under pressure from the engine lubrication system, enters drilled crankshaft through crankshaft rear end cover and is forced through the crankshaft and drilled connecting rods, lubricating bearings, piston pins, and pistons. Oil drains from the crankcase into the engine gear train cover, and then into the engine crankcase.

COMPRESSOR AIR INTAKE

The air compressor air inlet manifold is connected by a tube to the engine air cleaner manifold.

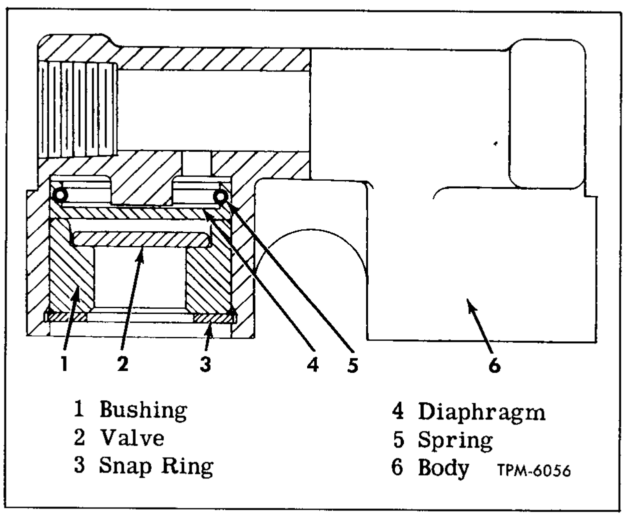


Figure 3—Governor Unloader

The air drawn into the air compressor is cleaned by the engine air cleaners.

COMPRESSOR AND GOVERNOR OPERATION

AIR COMPRESSOR OPERATION (Fig. 1)

1. Compressing

During downstroke of each piston, air is drawn into the cylinder through a flapper-type inlet valve in cylinder head. As each piston begins an upstroke, air above piston is compressed. When air pressure in cylinder becomes greater than air pressure in the cylinder head above the discharge valve, discharge valve is forced off valve seat. Air passes through discharge port into air line leading to air tank. As piston starts downstroke, the discharge valve returns to valve seat. Compressed air is prevented from returning to the cylinder and intake and compression cycle is repeated.

2. Not Compressing

When air pressure in system reaches maximum pressure for which governor is set, the governor operates and causes inlet valve plungers to hold inlet valves off valve seats. With inlet valves open, air passes freely back and forth between cylinders and compression is stopped. When air pressure in system is reduced to governor cut-in setting, governor again operates. Inlet valve plungers release the inlet valves, and compression of air is resumed.

GOVERNOR OPERATION

The air compressor governor consists of two separate units, a governor assembly and an unloader valve (figs. 2 and 3). The unloader valve is mounted directly on cylinder head. The governor assembly is bolted to a mounting bracket attached to two of the cylinder head studs.

Governor inlet port admits tank air to bottom of inlet valve. As air pressure increases, inlet valve is gradually forced upward from valve seat. When cut-out pressure is reached, inlet valve snaps to full open position. Plunger is also forced upward, compressing spring and seating exhaust valve. Tank air then passes through a small orifice in inlet valve, around outside of exhaust valve, through body cavity and connecting tube, to cavity in top of unloader. The pressure in unloader cavity forces unloader valves downward. Valves, in moving downward, depress inlet valve plungers. Plungers, in turn, open inlet valves in head to interrupt compression of air in cylinders. Pistons then merely move air back and forth between cylinders.

When tank pressure drops to cut-in point, plunger spring forces plunger, inlet valve, and exhaust valve downward. Inlet valve is returned to

valve seat and exhaust valve is opened. Open exhaust valve allows unloader air to escape through exhaust port in governor adjusting screw. As air pressure above unloader valves decreases, inlet valve plunger springs force unloader valves upward. Expanding springs also retract plungers. As inlet valves are released, compression of air is resumed.

AIR COMPRESSOR AND GOVERNOR MAINTENANCE

Perform the inspection and maintenance operations listed below, at intervals determined by severity of service.

1. Remove cylinder head and clean carbon from inlet and discharge valves. If valves are damaged in any way, replace with new parts.
2. Make sure compressor discharge line is not choked with carbon.
3. Check governor cut-in and cut-out pressures and adjust if necessary. Refer to "Governor Adjustment" later in this section.
4. Check compressor mounting bolts for looseness and tighten if necessary.
5. Lubricate compressor governor as directed in LUBRICATION (SEC. 13) of this manual.
6. Make sure all oil and air line connections are tight and not leaking.

GOVERNOR ADJUSTMENT

The following procedure covers adjustment with compressor installed on vehicle. Governor is mounted on compressor as shown in figure 1.

1. Loosen lock nut (2, fig. 2). Use a screwdriver on adjusting plug (1, fig. 2).
2. Turn adjusting screw in (clockwise) to increase cut-out setting, or out (counterclockwise) to decrease setting. One complete turn of adjusting screw will change cut-out pressure 20 psi.
3. When cut-out pressure setting of 120-127 psi is attained, lock adjusting plug with lock nut.

NOTE: Correct governor adjustment is to cut-in at 105 psi and to cut-out at 120-127. Range: 15 to 22 psi.

AIR COMPRESSOR REPLACEMENT

REMOVAL

1. Exhaust compressed air from air system.
2. Drain engine cooling system as directed in COOLING SYSTEM (SEC. 6) of this manual.
3. Disconnect water, air, and oil lines from compressor.
4. Remove nuts and lock washers from four studs attaching air compressor to gear train cover. Pull compressor straight back off studs and remove from vehicle.

INSTALLATION

1. Before installing compressor, examine drive hub on compressor crankshaft and drive disc on camshaft gear for worn or broken teeth. Check backlash between teeth in hub and teeth on drive coupling, also between teeth in drive disc and teeth on coupling. New limits are 0.000" to 0.001" backlash. If backlash is appreciably greater than this, drive disc or hub (or both) must be replaced.
2. Make sure mating surfaces of air compressor flange and gear train cover are clean. Place new compressor to gear train cover gasket on studs. Make sure that oil drain hole is free from gasket material.
3. Insert damper spring in drive coupling and place spring end of drive coupling into hub on compressor crankshaft. Place compressor in position on gear train cover, guiding teeth on coupling into mesh with teeth in drive disc. Install nuts and lock washers on studs and tighten firmly.
4. Connect all water, air, and oil lines, making sure connections are tight.
5. Make sure drain plug is installed in compressor cylinder head; then fill cooling system as directed in COOLING SYSTEM (SEC. 6) of this manual.

AIR COMPRESSOR OVERHAUL

COMPRESSOR DISASSEMBLY

(Refer to Figure 1)

The compressor crankcase, cylinder block, and cylinder head are so designed that these parts may be assembled in different ways to meet various installation requirements. Therefore, these parts should be marked with alignment marks prior to disassembly.

REMOVE GOVERNOR ASSEMBLY

1. Disconnect governor tube assembly from governor and unloader. Remove tube assembly.
2. Remove two governor bracket to compressor attaching bolts and lock washers. Remove governor and bracket assembly. Governor disassembly is covered under "Compressor Governor Overhaul" later in this section.

REMOVE UNLOADER ASSEMBLY

1. Remove two cap screws and lock washers attaching unloader assembly to cylinder head.
2. Remove unloader assembly. Remove two inlet valve plungers and plunger springs.
3. Unloader disassembly is covered under "Governor Unloader Overhaul" later in this section.

AIR COMP. AND GOVERNOR (MIDLAND)

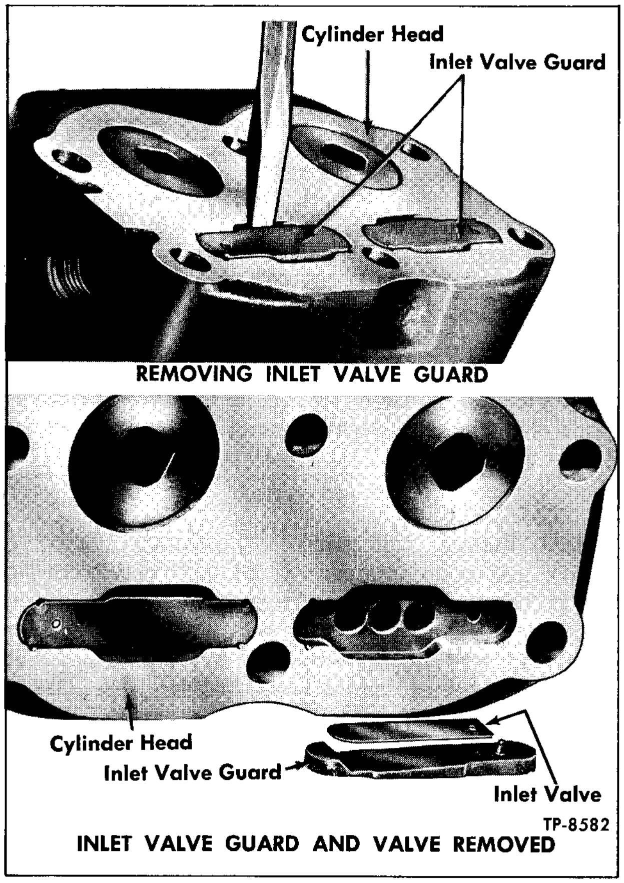


Figure 4—Inlet Valve and Guard Removal

REMOVE CYLINDER HEAD

Remove ten bolts and lock washers attaching cylinder head to cylinder block; then lift head assembly off block. Remove cylinder head gasket and discard.

DISASSEMBLE CYLINDER HEAD

1. Remove two discharge valve cap nuts from top of cylinder head; then lift two discharge valve springs out of head. Invert head to permit two discharge valves to fall out.
2. Using a screwdriver, pry inlet valve guard and pin assemblies from bottom of cylinder head; then remove inlet valves in manner illustrated in figure 4.
3. Remove discharge valve seats from bottom of cylinder head, using a short length of 7/16-inch square tool stock with corners ground off as a wrench adapter. Refer to figure 5 for adapter dimensions and application.
4. Note location of pipe plugs in cylinder head; then remove plugs to permit thorough cleaning of internal passages.

REMOVE CYLINDER BLOCK

Remove six nuts and lock washers from studs attaching cylinder block to crankcase. Lift cylinder

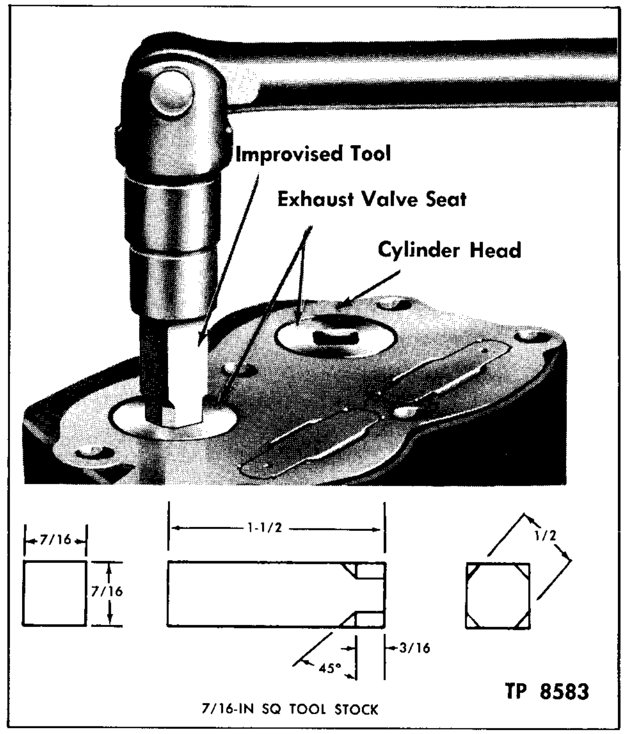


Figure 5—Removing or Installing Discharge Valve Seats

block off crankcase and pistons. Remove gasket from top of crankcase and discard.

REMOVE PISTON AND CONNECTING ROD ASSEMBLIES

1. Remove eight bolts and lock washers attaching crankcase bottom cover to crankcase; then remove cover and gasket. Discard gasket.
2. Before removing pistons, mark each piston so it may be re-installed in original position in proper cylinder. Connecting rods and caps are marked to show position of cap on rod.
3. Remove cotter pins and nuts from connecting rod bolts.
4. Remove connecting rod bearing caps and bearing halves. Do not remove bolts from rods.
5. Lift pistons and connecting rods from crankcase. Replace caps in original position on rods with halves in place to prevent damage to halves. Temporarily install nuts on bolts.

DISASSEMBLE PISTONS AND CONNECTING RODS

1. Remove piston pin lock rings from inside of piston; then press piston pin out of piston and connecting rod.
2. Remove compression and oil rings from piston. Use a conventional piston ring expander.

REMOVE CRANKSHAFT BEARING CAP

1. Remove four nuts and lock washers from

studs at end of crankcase. Remove crankshaft rear bearing cap and gasket from studs. Discard gasket.

2. Remove crankshaft seal ring from groove in stem.

REMOVE CRANKSHAFT AND BEARINGS

1. Position crankshaft so that connecting rod rear bearing journal is aligned with cut-out section of crankcase rear bearing core. Spread ends of small lock ring and remove from end of crankshaft.

2. Press crankshaft and rear bearing away from large lock ring and remove ring. Press out crankshaft and rear bearing assembly.

3. Leave rear bearing assembly on crankshaft unless replacement is necessary as indicated later under "Cleaning, Inspection, and Repair."

4. Press front bearing out of crankcase.

CLEANING, INSPECTION, AND REPAIR

CLEANING

After disassembly and before inspection, wash all parts thoroughly in a suitable cleaning solvent. Make sure all carbon deposits are removed from pistons and cylinder head. Probe drilled oil passages in crankshaft to make sure passages are open. Scrape all carbon from piston ring grooves in pistons.

INSPECTION AND REPAIR

Discard all gaskets, and crankshaft seal ring and obtain new parts for assembly. Inspect balance of parts and make necessary repairs or replacements as directed below, referring to figure 1 for identification of parts.

1. Cylinder Head and Valves

a. Examine cylinder head for cracks and for damaged threads in tapped openings. Replace head if any damage is evident.

b. Examine discharge valves and valve seats. If valves are deeply grooved on one side where they contact the seats, they may be turned over to use the unworn side. If valves have been previously turned over so that both sides are worn, or if otherwise damaged, replace with new parts. If valve seats are pitted or otherwise damaged, replace with new parts. If discharge valves are to be turned over or if new valves or seats are to be used, valves must be lapped to seats, using lapping compound. After lapping, thoroughly clean lapping compound from valves and seats.

NOTE: After lapping each valve to a seat, keep valve and seat together as a matched set; each valve must be installed on the seat to which it was lapped.

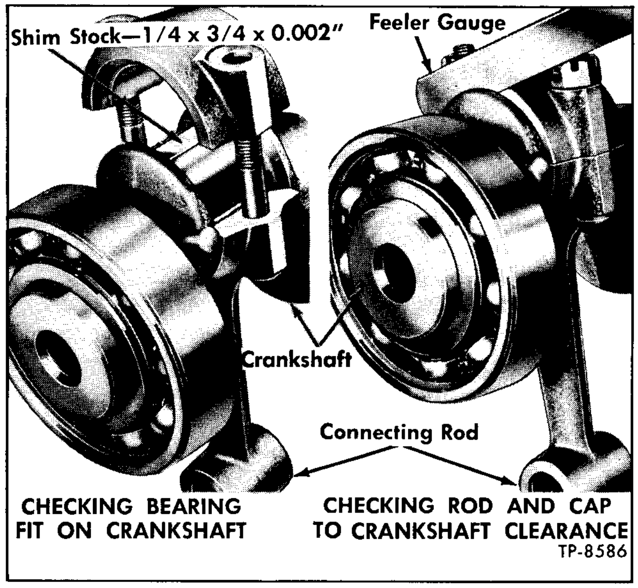


Figure 6—Checking Fit of Connecting Rod on Crankshaft

c. Inspect inlet valves and inlet valve guards for pitting or corrosion. If corrosion does not readily clean off without leaving pits, replace with new parts. Make sure dowel pin is tight in valve guard.

d. Inspect inlet valve plungers for distortion and for evidence of wear at both ends.

e. Check inlet valve plunger springs and discharge valve springs for free length, compressed length, distortion, or collapsed coils. If not within limits listed in "Specifications" at end of this group, replace with new parts.

2. Pistons, Connecting Rods, and Bearings

a. Examine pistons for scoring, cracks, or other damage. Measure outside diameter at each piston and compare this diameter with inside diameter of cylinder bore. If lower part of piston is more than 0.004-inch smaller in diameter than the cylinder bore, piston must be replaced with a new part.

b. Check fit of piston pins in pistons and connecting rod bushings. Pin must be light tap fit in piston and in bushing. Determine which part is worn and replace as necessary. To replace bushing in connecting rod, press old bushing out and press new bushing into place. Bushing must be finished after installation to inside diameter listed in "Specifications" at end of this group.

c. Check fit of compression and oil rings in ring grooves in pistons. Clearance between ring and ring groove must not exceed 0.003-inch. Place each ring in cylinder bore and measure ring gap. Gap must be within 0.006 to 0.013-inch. If clearances are not within these limits, new rings must be used at assembly.

d. Examine connecting rod bearing halves for scoring, pitting, or visible wear. If damage is evident, new halves must be installed. To check fit of bearings on crankshaft, install each connecting rod with bearing halves on crankshaft journal from which they were removed, using a 1/4 x 3/4-inch piece of 0.002-inch brass shim stock between bearing journal and bearing half (fig. 6). Tighten connecting rod bolt nuts to 5 to 8 foot-pounds torque. If bearing fit is correct, the 0.002-inch shim should lock the bearing on the journal. Check clearance between side of connecting rod and cap and cheek on crankshaft (fig. 6). If clearance exceeds 0.006-inch, new rods and caps must be used.

NOTE: Do not file or lap bearing caps or rods to take up clearance; always use new bearing halves if clearances are excessive.

3. Cylinder Block

a. Examine inside of cylinder bores for scoring or pitting. Check bores for out-of-round and taper. If out-of-round more than 0.002-inch from top to bottom of bore, replace with new cylinder block.

b. Examine studs in top of cylinder block. Replace bent stud or stud having damaged threads. When installing new stud, make certain that replacement stud is the same length as stud removed.

c. Examine cylinder block for cracks. Replace block if damaged in any way.

4. Crankshaft and Bearings

a. A bent or twisted crankshaft cannot be repaired. If connecting rod journals are scored on more than 20 percent of the bearing area or worn more than 0.003-inch under original diameter listed in "Specifications," replace with new crankshaft.

b. Threads, keyway, and all ground and machined surfaces must not be mutilated or worn.

c. Examine rear ball bearing on crankshaft and front bearing for worn or damaged balls; rotate bearings by hand to detect roughness. If wear, roughness, or damage is evident, bearings must be replaced. Pull damaged rear bearing off crankshaft, using a suitable puller.

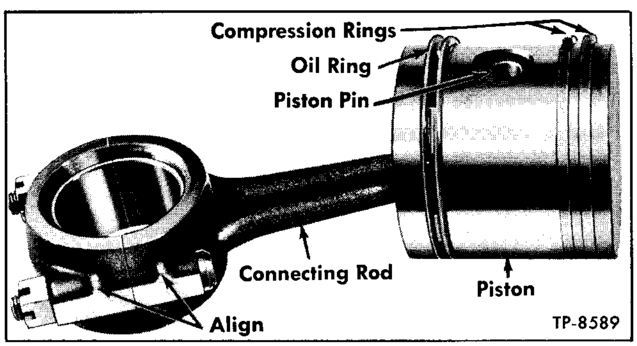


Figure 7—Piston and Connecting Rod Assembly

5. Crankcase

a. Examine crankcase for cracks or other damage. Replace with new part if damaged in any way.

b. Inspect studs in crankcase and replace any which are bent or have damaged threads. When replacing studs, be sure and install studs of proper length in same holes from which they were removed.

6. Crankshaft Bearing Cap

Examine crankshaft rear bearing cap and replace if cracked. Check diameter of stem against dimension listed in "Specifications." Replace bearing cap if stem is appreciably worn.

AIR COMPRESSOR ASSEMBLY

Coat crankshaft and bearings, connecting rods and bearings, pistons, pins, and bushings with engine oil before assembling. Refer to figure 1 for assembled position of parts.

INSTALL CRANKSHAFT AND BEARINGS

1. Press rear bearing on crankshaft (if removed) until inner race seats firmly against shoulder on crankshaft.
2. Insert crankshaft through rear of crankcase; then press in until rear bearing is just short of ring groove in bore of case.
3. Install the large snap ring in groove of case; then press rear bearing firmly against the snap ring.
4. Install small snap ring in groove of crankshaft, making sure snap ring is well seated in groove.
5. Press front bearing on crankshaft and into bore of crankcase.

INSTALL CRANKSHAFT BEARING CAP

1. Place new crankshaft O-ring seal in stem groove of crankshaft bearing cap. Install new gasket over studs at rear end of crankcase.
2. Install rear bearing cap with stem on cap entering hole in crankshaft. Attach cap to crankcase with four lock washers and four nuts.
3. Tighten stud nuts to 9-1/2 to 13 foot-pounds torque.
4. Rotate crankshaft. Relieve any binding in bearings by using extra gasket or shim stock between bearing cap and crankcase.

ASSEMBLE PISTONS AND CONNECTING RODS

1. Position connecting rod in piston and press piston pin into place.
2. Install lock rings in grooves at each end of piston pin.
3. Install compression and oil rings on pistons. Three rings are used on each piston, two compression rings at top and one ventilated oil ring at bottom (fig. 7).

NOTE: Compression rings must be installed with surface marked "TOP" facing top of piston.

4. Install connecting rod bearing halves into connecting rod and cap, making sure locks on bearing halves engage locking slots in rod and cap.

5. Tag or mark bearing caps and rods so that each cap will be installed on rod from which it was removed.

INSTALL PISTON AND CONNECTING ROD ASSEMBLIES AND CYLINDER BLOCK

1. Insert pistons into cylinder block from bottom side, compressing piston rings to permit rings to enter cylinder bores.

2. Place new gasket over studs on top of crankcase. Hold cylinder block over crankcase with lower ends of connecting rods extending just below top of crankcase; then lower cylinder block onto crankcase.

NOTE: Cylinder block must be positioned on crankcase using alignment marks made earlier. If a new unmarked part is being used, position cylinder block so the short stud on top of block is at the left-hand side when viewed from drive end of crankshaft. Attach cylinder block to crankcase with six lock washers and six nuts. Tighten nuts to 9-1/2 to 13 foot-pounds torque.

3. Turn the assembly over and position connecting rods on crankshaft journals, making sure bearing halves are in place. Install connecting rod bearing caps and bearing halves, matching bearing cap and rod as shown in figure 7. Install nuts on connecting rod bolts. Tighten to 5 to 8 foot-pounds torque and secure with new cotter pins.

4. Place new gasket and bottom cover on crankcase. Attach with cap screws and lock washers. Tighten firmly.

ASSEMBLE CYLINDER HEAD

1. Install discharge valve seats, with copper washers, in openings in bottom of cylinder head and tighten firmly (fig. 5). Bottom of valve seats must be flush with or slightly inside the bottom face of cylinder head when fully tightened.

2. Place one inlet valve in recess in bottom of cylinder head, with hole in valve aligned with valve guard pin hole in head. Place inlet valve guard on top of inlet valve, with dowel pin inserted through hole in inlet valve into cylinder head. Tap guard firmly into place; then stake in place at four points (fig. 8). Install the other inlet valve and valve guard in the same manner. After both valves are installed, turn cylinder head over and check operation of valves. Using one of the inlet valve plungers without spring, insert plunger down through cylinder head onto inlet valve. Press inlet valve down against valve guard; then make sure inlet valve springs back up when released.

3. Drop discharge valves through top of cylinder head onto discharge valve seats, making sure each valve is installed on seat to which it was lapped. Place discharge valve springs over discharge valve cap nuts; then thread cap nuts into cylinder head and tighten firmly.

INSTALL CYLINDER HEAD

Place new cylinder head gasket on top of cylinder block so cut-out portion of large holes will be adjacent to discharge valve seats when cylinder head is installed. Install cylinder head aligning marks made before disassembling. Install ten attaching bolts and tighten to 9-1/2 to 13 foot-pounds torque.

INSTALL UNLOADER ASSEMBLY

1. Install two inlet valve plungers and plunger springs in cylinder head.

2. Position unloader assembly on cylinder head and attach with two bolts and lock washers. Tighten bolts securely.

INSTALL GOVERNOR ASSEMBLY

1. Position governor and bracket assembly on two studs on cylinder head.

2. Install two nuts and lock washers on studs. Tighten nuts firmly.

3. Connect tube assembly to unloader and governor assemblies. Make sure connections are tight.

TESTING REBUILT AIR COMPRESSOR

Connect an oil supply line having at least 15 pounds pressure to crankshaft rear bearing cap; provisions must be made for unrestricted draining of oil from crankcase during test. If tests are be-

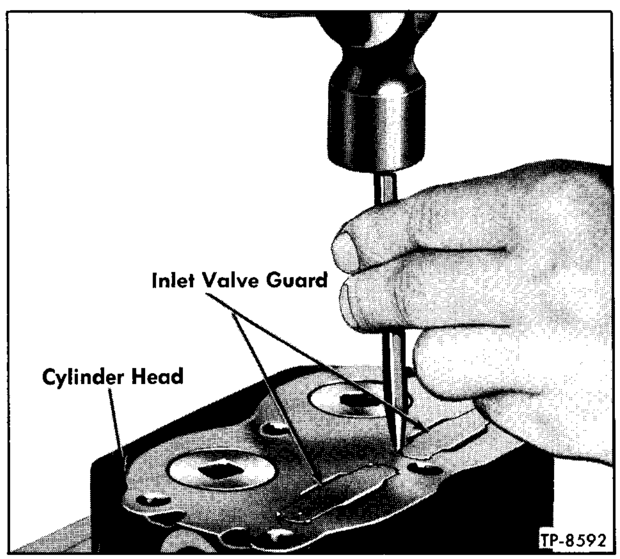


Figure 8—Staking Inlet Valve Guard in Cylinder Head

AIR COMP. AND GOVERNOR (MIDLAND)

ing made in dusty atmosphere, connect a suitable air strainer to compressor air inlet opening.

1. Run-in Test

With compressor connected to a source of power (at least 2-3/4 horsepower) to run it at 1250 rpm, run compressor for one-half hour with discharge port open to atmosphere. Check during this test for oil leaks, overheating, and excessive noise.

2. Oil Passing Test

Oil passing test is made by running air compressor for one-half hour at 1250 rpm, pumping against 50 pounds air pressure, with an oil trap connected into discharge line. Oil passed during this test must not exceed two cubic centimeters.

3. Efficiency Test

Efficiency test is made by running compressor for one-half hour at 1250 rpm, with discharge port connected to an air tank. With a 1/16-inch diameter relief hole in discharge line open continuously, compressor should maintain a pressure of at least 105 psi in air tank.

COMPRESSOR GOVERNOR OVERHAHL

Remove governor from air compressor as directed previously in "Air Compressor Overhaul."

DISASSEMBLY

Key numbers in text refer to figure 9.

1. Remove lock nut (1); then remove adjuster plug (2), spring (5), and spring guide (6).
2. Remove governor body (3), and spacer washer (4) from housing (10). Remove piston valve (7), valve seat (8), and spring (9) from housing (10).
3. Remove end cap (14), washer (13), filter (12), and filter screen (11) from housing (10).

CLEANING AND INSPECTION

1. Wash all metal parts in cleaning solvent. Blow parts dry.
2. Check governor spring (5) and valve spring (9) for free length, compressed length, distortion, or collapsed coils.
3. Inspect governor housing (10) and body (3) for cracks or other damage. Check for crossed or stripped threads.
4. Check adjuster plug (2) and end cap (14) for crossed or stripped threads.
5. Inspect piston valve (7) and valve seat (8) for roughness or damage. Replace parts if not in first class condition.
6. Check spring guide (6) for distortion or other damage.

ASSEMBLY

Key numbers in text refer to figure 9.

1. Apply a thin film of light engine oil to valve seat (8) and valve (7). Position valve spring (9), valve seat (8), and piston valve (7) in housing (10).
2. Position washer (4) on body (3), then thread body (3) into housing (10).
3. Install spring guide (6) and spring (5); then thread adjuster plug (2) into body (3). Install lock nut (1).
4. Install filter screen (11), filter (12), washer (13), and end cap (14) in governor housing (10).
5. After installing governor on air compressor, perform "Governor Adjustment" as previously directed in this section.

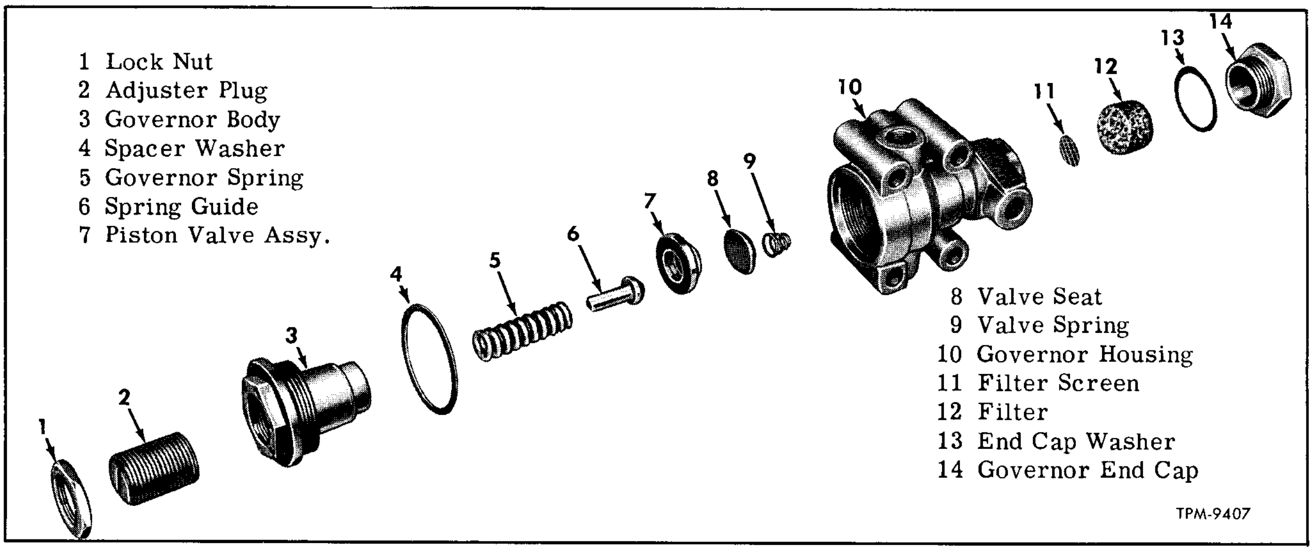


Figure 9—Air Compressor Governor Components

GOVERNOR UNLOADER OVERHAUL

Remove unloader assembly from air compressor as directed previously in "Air Compressor Overhaul." Key numbers in text following refer to figure 10.

DISASSEMBLY

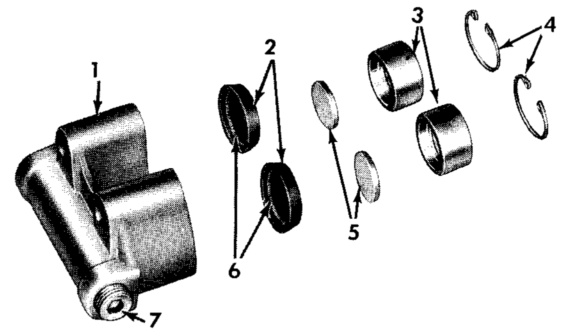
1. Remove two snap rings (4) from housing (1).
2. Remove bushings (3), two valve discs (5), diaphragms (2), and expander springs (6) from housing. Should difficulty be encountered in removing these parts, apply air pressure to body to force out parts.

CLEANING AND INSPECTION

1. Clean all parts in cleaning solvent. Blow parts dry.
2. Inspect all parts for wear or damage. Replace all parts that are not in first class condition.

ASSEMBLY

1. Apply a thin film of light engine oil to bushings (3), diaphragms (6), and housing (1) before assembly.
2. Install expander springs (6) around inside of diaphragms (2); then install these parts in housing.
3. Place two valve discs (5) in recess of bushings (3); then install in housing.
4. Install snap rings (4) retaining previously installed parts in housing.
5. Test assembly with air. Unloader should withstand a pressure of 100 psi without leaking.



1 Unloader Housing
2 Diaphragms
3 Bushings
4 Snap Rings
5 Valve Discs
6 Expander Springs
7 Pipe Plug

TPM 9411

Figure 10—Governor Unloader Components

Refer to next page for "Specifications."

SPECIFICATIONS

MAKE .... Midland-Ross

MODEL N-5904

TYPE .... 2 Cylinder, Water Cooled, Engine Oil Lubricated, and Flange Mounted

CAPACITY (at 1250 rpm) .... 12 Cu. Ft. Per Min.
Cylinder Bore .... 2.3745″-2.3750″

PISTON
- Diameter at top lands .... 2.366″-2.368″
- Diameter from 2nd groove down .... 2.3720″-2.3725″

PISTON PIN
- Outside Diameter .... 0.4998″-0.500″
- Inside Diameter .... 0.28125″
- Length .... 2$\frac{1}{16}$″
- Material .... SAE #1020 Steel

PISTON PIN BUSHING
- Outside Diameter .... 0.562″-0.563″
- Inside Diameter .... 0.5002″-0.5003″
- Width .... 0.80″

PISTON OIL RING
- Outside Diameter .... 2.375″
- Inside Diameter .... 2.225″-2.245″
- Width .... 0.1870″
- Thickness .... 0.065″-0.075″
- Gap .... 0.005″-0.010″

PISTON TOP COMPRESSION RING
- Outside Diameter .... 2.375″
- Inside Diameter .... 2.145″-2.165″
- Width .... 0.0930″-0.0940″
- Thickness .... 0.105″-0.115″
- Gap .... 0.005″-0.010″

PISTON 2ND COMPRESSION RING
- Outside Diameter .... 2.375″
- Inside Diameter .... 2.145″-2.165″
- Width .... 0.930″-0.940″
- Thickness .... 0.105″-0.115″
- Gap .... 0.005″-0.010″

CONNECTING ROD BUSHING (PISTON PIN)
- Outside Diameter .... 0.562″-0.563″
- Inside Diameter .... 0.5002″-0.5003″
- Thickness .... 0.042″-0.044″
- Width .... 0.80″

CONNECTING ROD BEARING HALVES
- Lock Fit on Crankshaft Journal $\frac{1}{4}$″ x $\frac{3}{4}$″ x 0.002″ Shim Between Half and Journal.

CRANKSHAFT
- Connecting Rod Journal Diameter .... 1.1230″-1.1235″
- Rear Bearing Journal Diameter .... 1.3779″-1.3784″
- Front Bearing Journal Diameter .... 1.3779″-1.3784″
- Length .... 7.44″

CRANKSHAFT BALL BEARINGS (Front and Rear)
- Outside Diameter .... 2.8341″-2.8346″
- Inside Diameter .... 1.3775″-1.3780″
- Width .... 0.6688″-0.6693″
- Number of Balls 9
- Size of Balls .... $\frac{7}{16}$″

SPRINGS
- Discharge Valve Springs
  - Free Length .... $\frac{31}{32}$″
  - Length Under 3.5 lb. Load .... $\frac{47}{64}$″
  - Solid Height .... $\frac{21}{32}$″
- Unloader Springs
  - Free Length .... $\frac{27}{32}$″
  - Length Under 3 lb. Load .... $\frac{15}{32}$″
  - Solid Height .... $\frac{11}{32}$″
- Governor Spring
  - Free Length .... 1.36″
  - Length Under 30.8 lb. Load .... 1.22″
  - Solid Height .... 0.89″
- Governor Valve Spring
  - Free Length .... 0.288″
  - Length Under 3.52 lb. Load .... 0.112″
  - Solid Height .... 0.088″
- Unloader Expander Spring
  - Diameter Free Position .... 0.750″-0.770″
  - Coils Per Inch 64

AIR GOVERNOR PRESSURE SETTING
- Cut-In .... 105 Psi
- Cut-Out .... 120-127 Psi
- Pressure Range .... 15-20 Psi

Rotary Air Compressor

GENERAL

Rotary air compressor is used as special equipment on some vehicles. Air dome and reservoir assembly is attached to a mounting plate at the rear end of the compressor, and the compressor control valve assembly is mounted on top of the compressor stator. Compressor is flange mounted to engine gear train cover and is driven from the engine camshaft gear in the same manner shown for the standard air compressor on page 119, except that no sleeve and damper spring are used in the drive coupling.

Compressor air intake is connected to the engine air cleaner manifold so that air drawn into the compressor is cleaned by the engine air cleaners. The compressor stator is water-jacketed and connected to the engine cooling system. Engine oil, under pressure from the engine lubrication system, is introduced into the oil reservoir through the lubricating valve.

Figure 1 shows the compressor and control valve assembly, air dome and oil reservoir assembly, compressor discharge muffler, and compressor discharge line check valve installed, together with the connecting water, oil, and air lines. The compressor, control valve, and air dome and oil reservoir assembly and their interconnecting components and tubes are also shown in figure 3.

OPERATION

(Refer to Figures 2 and 3)

COMPRESSOR

Basically, the rotary compressor consists of a cylindrical stator, two end plates, and a rotor and shaft assembly. Stator end plates are equipped with sleeve bearings (bushings) which support the rotor shaft. The diameter of the rotor is smaller than the bore of the stator, and the bearings are located in the end plates so that the rotor is positioned eccentric in relation to the stator bore. Rotor to stator bore clearance is 0.001" at the top (between air discharge and air intake ports) and approximately 1/4 inch at the bottom.

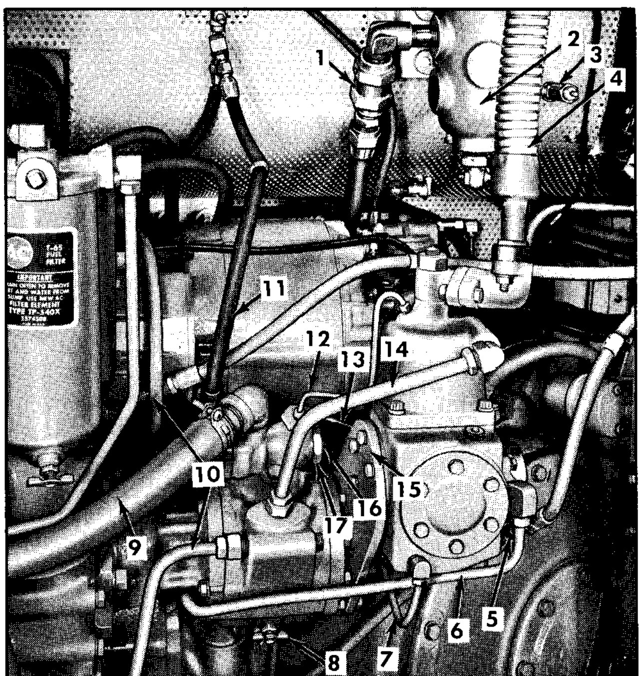
Four rotor blades are carried in slots in the rotor. The slots are equally spaced and are arranged so that the trailing edge of each blade forms an acute angle with the stator bore. Two springs and push pins are installed behind each blade, assisting centrifugal force in keeping the blades in contact with the stator bore. The rotor blades divide the clearance between the rotor and stator into four chambers, which have their volume progressively increased and reduced each revolution of the rotor. The four chambers each pass through three stages each revolution of the rotor -- intake, compression, and discharge.

Intake

Chamber between rotor blades is open to air intake port. As rotor and blades progress, chamber area increases, creating vacuum, drawing air into the chamber from the engine air cleaner manifold.

Compression

As rotor and blades continue to progress, the chamber trailing blade closes the intake port. Chamber area is reduced, compressing the trapped air.



1 Discharge Line Check Valve
2 Discharge Muffler
3 Safety Valve
4 Flexible Discharge Tube
5 Oil Supply Line (from engine)
6 Oil Return Tube
7 Oil Inlet Tube
8 Stator Drain Cock
9 Air Inlet Hose
10 Water Lines
11 Tank to Control Valve Air Line
12 Relief Valve Tube
13 Vacuum Tube
14 Compressor Discharge Tube
15 Dome and Reservoir Mounting Plate
16 Control Valve Adjusting Screw
17 Adjusting Screw Lock Nut

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Figure 1—Rotary Air Compressor Installed

ROTARY AIR COMPRESSOR

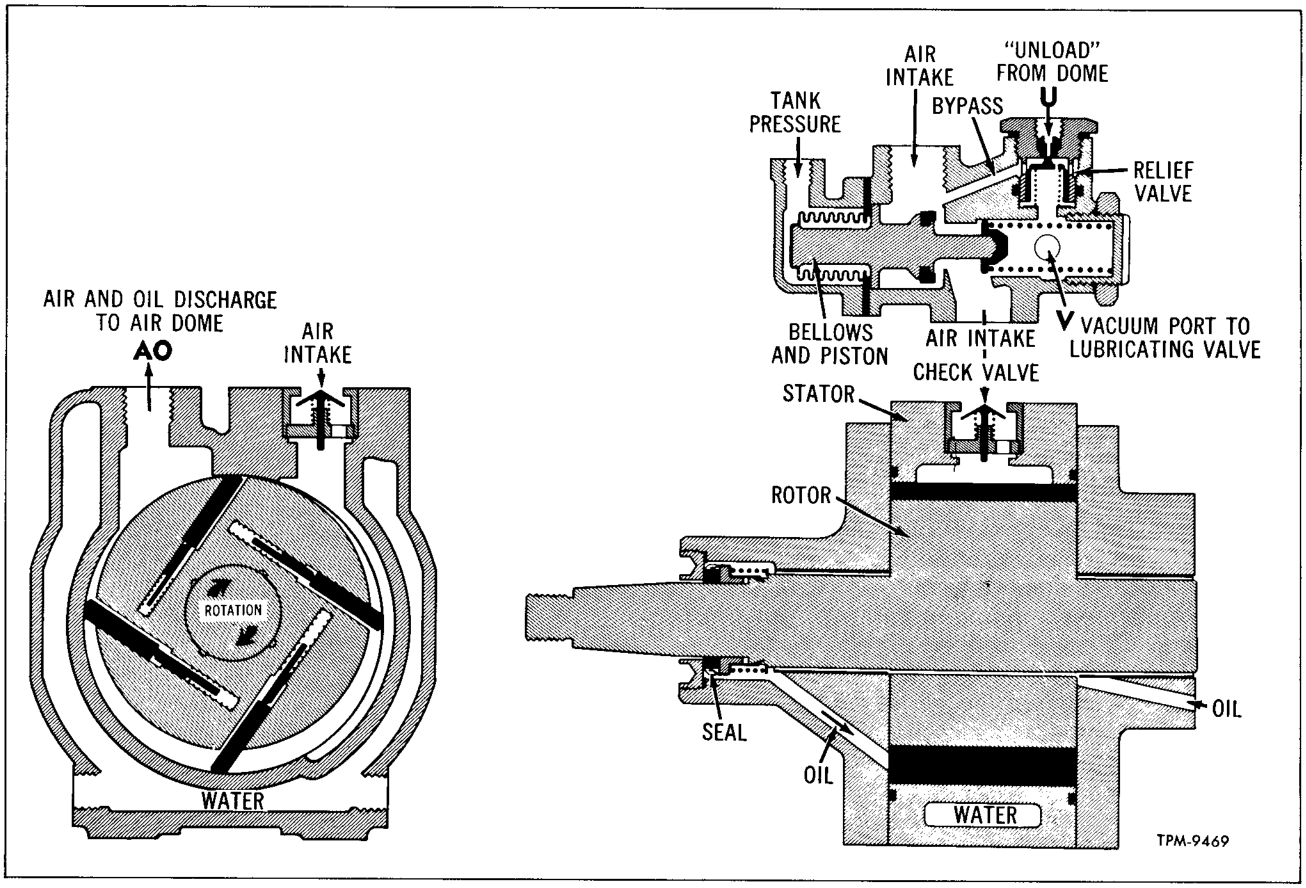


Figure 2—Compressor and Control Valve Operation

Discharge

Rotor and blades complete the revolution as the leading blade passes the stator discharge port, and the compressed air, with oil, is forced out the port and through the discharge tube into the air dome.

The intake check valve in the stator intake port closes to prevent "blow-back" which might occur if the compressor is pumping against high reservoir pressure at low speed.

SEPARATION OF AIR AND OIL

Compressed air, mixed with oil, is discharged into the air dome where it spins at high velocity. Centrifugal force and baffling separate the oil from the air. Compressed air discharges through the dome outlet check valve into the line leading to the air tanks. The oil drains into the reservoir, from where it is fed back to the compressor for lubrication purposes, with the excess returning to the engine crankcase.

COMPRESSOR LUBRICATION

Oil is supplied to the compressor through the tube connecting the bottom of the oil reservoir to the compressor rear end plate cap. Oil in the reservoir is always subjected to air pressure, providing a force feed system circulating oil to all bearings and sealing surfaces. Oil which circulates through the compressor is discharged, with the compressed air, into the air dome.

LUBRICATING VALVE

Engine oil, under pressure from the engine lubrication system, enters the lubricating valve through a port containing a screen and a restriction orifice. A gravity feed oil return tube is connected to the same cavity in the lubricating valve; when the lubricating valve poppet valve is closed, oil simply drains back into the engine crankcase through the oil return tube.

A tube connects the air inlet cavity in the control valve to the inner side of the piston in the lubricating valve. Vacuum developed in the air intake cavity during the "cycle-off" permits atmospheric pressure against the outer side of the lubricating valve piston to stroke the piston, unseating the poppet valve into the oil reservoir. Unloading dome pressure blows off through the oil return tube as well as through the control valve. Oil then enters the reservoir through the poppet opening, or excess oil in the reservoir above the proper

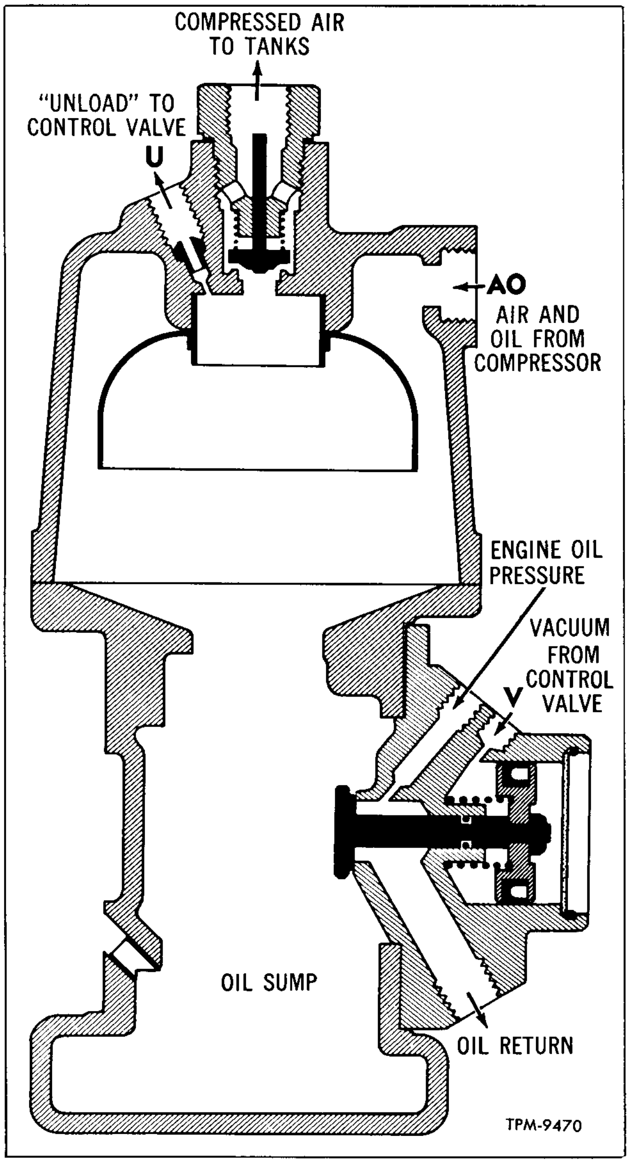


Figure 3—Air Dome, Reservoir, and Lubricating Valve Operation

level spills out through the poppet valve into the oil return tube. When "cycle-on" occurs, vacuum drops and spring pressure closes the poppet valve.

TEMPERATURE CONTROL

The operating temperature of the compressor is controlled by three mediums: water, oil, and air. Water from the engine cooling system is circulated through the cored passages which surround the stator bore. Oil in excess of lubrication requirements is circulated through the compressor, carrying heat back into the dome. Heat carried by the oil and compressed air is dissipated into the air through the oil and air discharge tube and from the dome itself.

ROTOR SHAFT SEAL

A positive drive seal prevents loss of air and oil through the rotor shaft clearance at the front end plate. A seal retainer, holding a synthetic seal ring which grips the shaft, is driven by lugs which engage slots machined into the rotor shaft. The retainer also drives a carbon seal ring located between the synthetic seal ring and the seal retainer ring threaded into the front end plate. The carbon seal ring and the seal retainer ring have matching flat sealing surfaces. Seal surface pressure is provided by a seal spring compressed between the seal retainer and a spring retaining washer.

CONTROL VALVE

The air pressure control valve, mounted on top of the compressor stator, controls the air system pressure by starting and stopping the compressor pumping cycle. Control valve is adjusted to stop compression when air system pressure reaches 117-120 psi, and starts compression when system pressure drops 10 to 15 pounds below the maximum pressure limit.

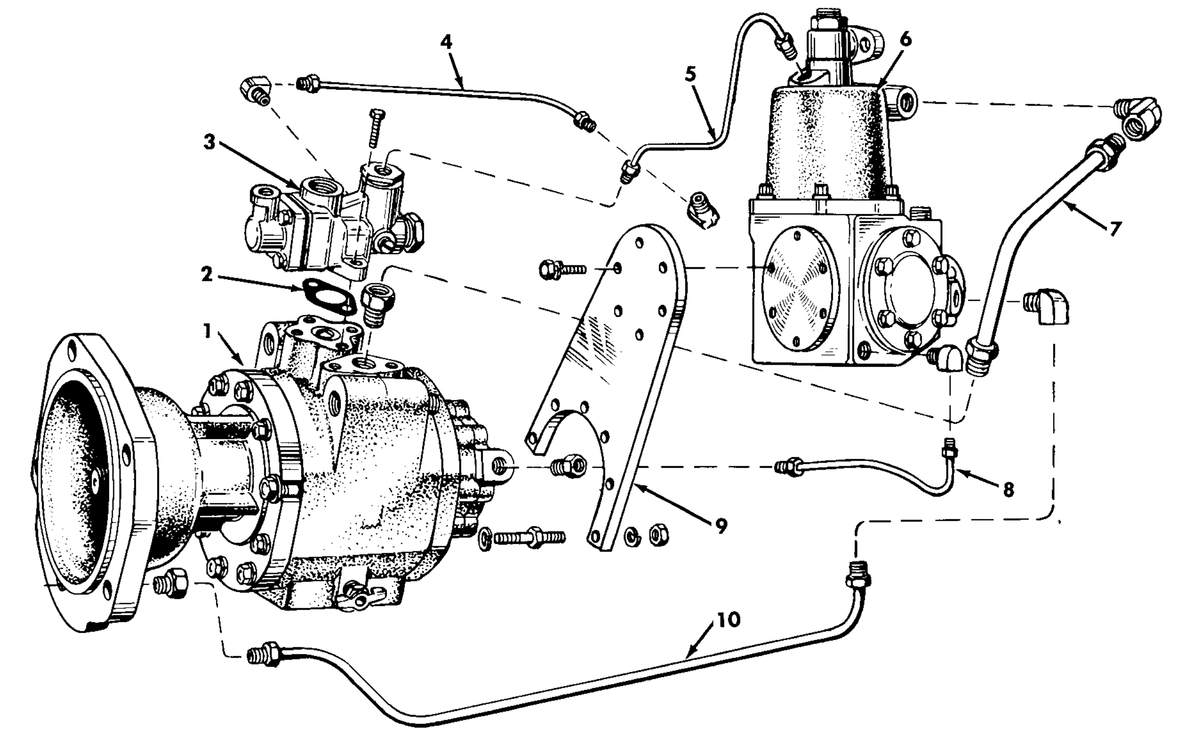
Two valves in the control valve assembly operate to stop and start the pumping cycle as follows:

1. Stopping the Pumping Cycle

a. Closing the air intake port. The control valve bellows is always subjected to air system pressure through an air line from vehicle air tank connected to the bellows cap. When system pressure reaches the maximum pressure limit, the increasing force against the bellows overcomes the pressure of the pressure regulating spring, forcing the control valve piston toward its seat in the intake chamber. As the piston approaches its seat, the intake opening is restricted and the compressor creates a vacuum ahead of the piston which accelerates its movement. With piston cup seated, air intake is closed and compression is stopped.

b. Unloading air pressure from dome. The air dome is connected to the control valve relief valve by the relief valve tube. The relief valve is vented to the air intake chamber, ahead of the control valve piston seat, through a drilled bypass in the control valve body. The cavity below the relief valve piston opens into the vacuum side of the intake chamber. Vacuum, created when the intake closes, permits air pressure from air dome to unseat the relief valve. Air pressure in the dome then exhaust through the drilled bypass into the air intake and back to the engine air cleaner manifold. A limited amount of air passes through the bleed hole in the top of the relief valve into the compressor air intake, maintaining pressure lubrication and cooling.

ROTARY AIR COMPRESSOR



1 Air Compressor Assembly
2 Control Valve Gasket
3 Control Valve Assembly
4 Vacuum Tube
5 Relief Valve Tube
6 Air Dome and Oil Reservoir Assembly
7 Compressor Discharge Tube
8 Reservoir to Compressor Oil Inlet Tube
9 Dome and Reservoir Mounting Plate
10 Oil Return Tube

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Figure 4—Air Compressor, Dome and Reservoir, Control Valve, and Interconnecting Tubes

2. Starting the Pumping Cycle

a. Opening the air intake port. As air pressure in system is reduced, the pressure on the control valve bellows also decreases. When pressure has dropped 10 to 15 pounds below the cut-out point, the pressure regulating spring overcomes the vacuum and the force of the bellows and forces the control valve piston off its seat, opening the air intake port.

b. Closing dome relief valve. Opening the air intake port, admitting air into the compressor stator, destroys the vacuum below the relief valve. This permits the relief valve spring to close the relief valve, closing off the vent to the dome.

CONTROL VALVE ADJUSTMENT

To check and adjust pressures at which the control valve stops and starts the pumping cycle, remove pipe plug (12, fig. 6) from outlet check valve guide and connect a test air pressure gauge to this port.

1. Start engine and run at a fast idle until pressure reading on gauge stops increasing. This indicates that the control valve has stopped the compressor pumping cycle. Pressure reading on gauge should be 117-120 psi.

2. To adjust cut-out pressure, loosen lock nut (17, fig. 1) and turn adjusting screw (16, fig. 1) clockwise to increase cut-out pressure or counter-clockwise to decrease it. One complete turn of adjusting screw will change the cut-out pressure about 10 psi. Tighten lock nut on adjusting screw after correct adjustment is obtained.

3. With engine idling, reduce air pressure in system by a series of brake applications until pressure on gauge stops decreasing. This indicates that the control valve has started the pumping cycle. Pressure reading on gauge should be 10-15 psi below the cut-out pressure. If the control valve does not start the pumping cycle at 10-15 psi below the cut-out pressure, it indicates dirty or sticking control valve parts or a weakened pressure regulating spring. This requires disassembling and cleaning or replacing control valve parts.

UNIT REPLACEMENT

The compressor and control valve assembly, together with the air dome and reservoir assembly, can be removed and installed as a complete assembly. The air dome and reservoir assembly or the control valve assembly can be replaced without removing the compressor from the engine. Refer to figure 4 for exploded view of the compressor, control valve, and dome and reservoir assembly and their interconnecting components.

CONTROL VALVE REPLACEMENT

Key numbers in text refer to figure 1 except where otherwise indicated.

Removal

1. Exhaust air pressure from system by opening drain cock in air tank. Close drain cock after air pressure is exhausted.
2. Disconnect air inlet hose (9) from top of control valve.
3. Disconnect vacuum tube (13) and relief valve tube (12) from control valve.
4. Disconnect tank to control valve air line (11) from control valve bellows cap.
5. Remove two cap screws and lock washers attaching control valve to compressor stator. Remove control valve assembly (3, fig. 4) and gasket (2, fig. 4).
6. Overhaul control valve as directed later under "Control Valve Overhaul."

Installation

1. Make sure stator intake check valve assembly (13, fig. 7) is in place in top of stator. Place gasket (2, fig. 4) on stator, then install control valve assembly (3, fig. 4) and secure with two cap screws and lock washers. Tighten cap screws firmly.
2. Connect tank to control valve air line (11) to control valve bellows cap.
3. Connect vacuum tube (13) and relief valve tube (12) to control valve ports.
4. Connect air inlet hose (9) to top of control valve.
5. Make sure mounting cap screws and all air tube connections are firmly tightened.
6. Build up air pressure in system, then adjust control valve cut-out pressure setting, if necessary, as previously directed under "Control Valve Adjustment."

AIR DOME AND RESERVOIR REPLACEMENT

Key numbers in text refer to figure 1 except where otherwise indicated.

Removal

1. Exhaust air pressure from system by opening drain cock in air tank. Close drain cock after air pressure is exhausted.
2. Place a receptacle under reservoir to catch oil, then disconnect oil inlet tube (7) from elbow at bottom of reservoir and drain oil from reservoir.
3. Disconnect oil return tube (6) and vacuum tube (13) from lubricating valve body.
4. Remove two bolts attaching elbow on flexible discharge tube (4) to discharge fitting at top of air dome.
5. Disconnect compressor discharge tube (14) from air dome.
6. Remove six cap screws and lock washers attaching reservoir to mounting plate (15), then remove dome and reservoir assembly.
7. Overhaul air dome and lubricating valve components as directed later under "Air Dome and Reservoir Overhaul."

Installation

1. Position air dome and reservoir assembly at mounting plate and attach with six cap screws and lock washers. Tighten cap screws firmly.
2. Connect vacuum tube (13), relief valve tube (12), compressor discharge tube (14), oil inlet tube (7), and oil return tube (6). Tighten connector nuts firmly.
3. Connect flexible discharge tube (4) to discharge fitting at top of air dome, using two bolts, lock washers, and nuts.
4. Remove pipe plug (13, fig. 6) from upper rear corner of oil reservoir and pour a sufficient amount of oil (same as used in engine) into the reservoir to provide initial compressor lubrication.

COMPRESSOR REPLACEMENT

Key numbers in text refer to figure 1.

Removal

1. Exhaust air pressure from system by opening drain cock in air tank. Close drain cock when air pressure is exhausted.
2. Open drain cock (8) and permit water to drain from compressor stator.
3. Remove two bolts attaching elbow on flexible discharge tube (4) to discharge fitting at top of air dome.
4. Disconnect tank to control valve air line (11) from control valve bellows cap.
5. Disconnect air inlet hose (9) from control valve.
6. Disconnect water lines (10) from compressor stator.
7. Remove nuts and lock washers from four compressor mounting studs. Lift compressor, with dome and reservoir assembly, straight off studs in gear train cover. Remove gasket from mounting studs.

ROTARY AIR COMPRESSOR

8. If compressor is to be overhauled, remove interconnecting tubes (fig. 4), then remove dome and reservoir assembly and control valve assembly from compressor.

Installation

1. Before installing compressor, examine hub on compressor rotor shaft and drive disc on engine camshaft gear for worn or broken teeth. Check backlash between teeth on drive coupling and teeth in drive disc and hub. New limits are 0.000 to 0.001 inch. If backlash is appreciably greater than this, drive disc or hub (or both) must be replaced.
2. Make sure mating surfaces of compressor mounting flange and engine gear train cover are clean. Place new gasket over studs in gear train cover.
3. If control valve assembly and dome and reservoir assembly were removed from compressor, assemble these parts to compressor, referring to figure 4 for position of tubes and fittings.
4. Insert one end of drive coupling into hub on compressor rotor shaft; then position compressor on gear train cover, guiding teeth on drive coupling into mesh with teeth in drive disc. Install lock washers and nuts on studs and tighten firmly.
5. Connect air inlet hose (9) to elbow and nipple on top of control valve.
6. Connect tank to control valve air line (11) to control valve bellows cap.
7. Connect elbow on flexible discharge tube (4) to discharge fitting at top of air dome, using two bolts, lock washers, and nuts.
8. Connect water lines (10) to compressor stator.
9. Make sure all hose and tube connections are securely tightened. Close stator drain cock and fill engine cooling system.
10. If oil reservoir was drained, remove pipe plug (13, fig. 6) and pour a sufficient amount of oil (same as used in engine) into the reservoir to provide initial compressor lubrication.
11. Build up air pressure in system and adjust control valve cut-out pressure, if necessary, as previously directed under "Control Valve Adjustments."

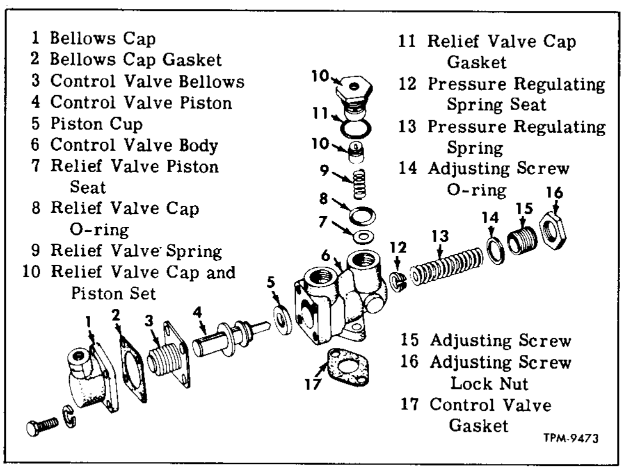


Figure 5—Control Valve Components

CONTROL VALVE OVERHAUL

(Key Numbers in Text Refer to Figure 5)

DISASSEMBLY

1. Unscrew relief valve cap (10) from control valve body and remove relief valve assembly. Remove cap gasket (11). Use a pointed instrument to remove O-ring (8) and piston seat (7).
2. Remove four cap screws and lock washers attaching bellows cap (1) to body. Remove bellows cap (1), gasket (2), bellows (3), and piston (4). Remove cup (5) from piston.
3. Loosen lock nut (16), then unscrew adjusting screw (15) from body. Remove O-ring (14), pressure regulating spring (13), and spring seat (12).

CLEANING AND INSPECTION

1. Thoroughly wash all parts in cleaning solvent and wipe dry. Blow out internal passages with compressed air.
2. Discard O-rings (8 and 14), gaskets (2, 11, and 17), and piston cup (5) and obtain new parts for assembly.
3. Check tension of springs (8 and 13) against "Specifications" at end of this section. Replace springs not within specified limits.
4. Inspect relief valve piston and cap (10). If seat on piston or in cap are worn or damaged, replace with new parts. Cap and piston are furnished in matched, lapped sets and must be replaced as a set.
5. Make sure seat in body contacted by piston cup (5) is clean and smooth.
6. Examine bellows for evidence of cracks or other damage. Replace if not in good condition.

ASSEMBLY

1. Install new cup (5) in groove in piston (4) with lip of cup facing small end of piston.
2. Insert piston assembly into body, then install bellows (3), gasket (2), and end cap (1). Air line port on end cap must be at top. Attach end cap to body with four cap screws and lock washers. Tighten cap screws firmly.
3. Install spring seat (12), pressure regulating spring (13), and adjusting screw in body. Thread adjusting screw in until approximately one-half inch of screw extends out of body. Place O-ring over adjusting screw and work into chamfer in body, then install lock nut (16).
4. Place relief valve piston seat (7) in relief valve bore. Install O-ring (8) in groove in relief

valve bore. Place gasket (11) on relief valve cap and place piston and spring (9) in relief cap, then thread cap into body. Be sure end of cap does not dislodge O-ring from groove as cap is threaded into place. Tighten cap firmly.

AIR DOME AND RESERVOIR OVERHAUL

(Key Numbers in Text Refer to Figure 6)

DISASSEMBLY

1. Remove four special cap screws attaching air dome (5) to reservoir body (3). Separate dome from body and remove gasket (4).
2. Unscrew outlet check valve guide (11) from top of dome, then remove discharge fitting (7), check valve spring (10), and check valve (9). Remove gasket (8) from valve guide.
3. Remove six cap screws (4 short, 2 long) and lock washers attaching lubricating valve assembly to reservoir body. Separate valve assembly from body and remove gasket (14).
4. Remove filter retaining ring (26) and filter (25) from lubricating valve body (18). Using pliers on knurled edge of poppet (15) and wrench on valve stem nut (24), separate parts at one end. Remove parts from body, then hold valve stem in soft vise jaws to separate parts at remaining end. Remove seal (16) from poppet (15), remove O-ring (20) from valve stem (19), and remove cup (23) from piston (22).
5. It is not necessary to remove spacer (1) or cover (28) from reservoir.

CLEANING AND INSPECTION

1. Thoroughly wash all parts in cleaning solvent and wipe dry. Blow out drilled passages with compressed air. Blow air through pressure port in lubricating valve body from inside to clean strainer which is pressed into port. Make sure

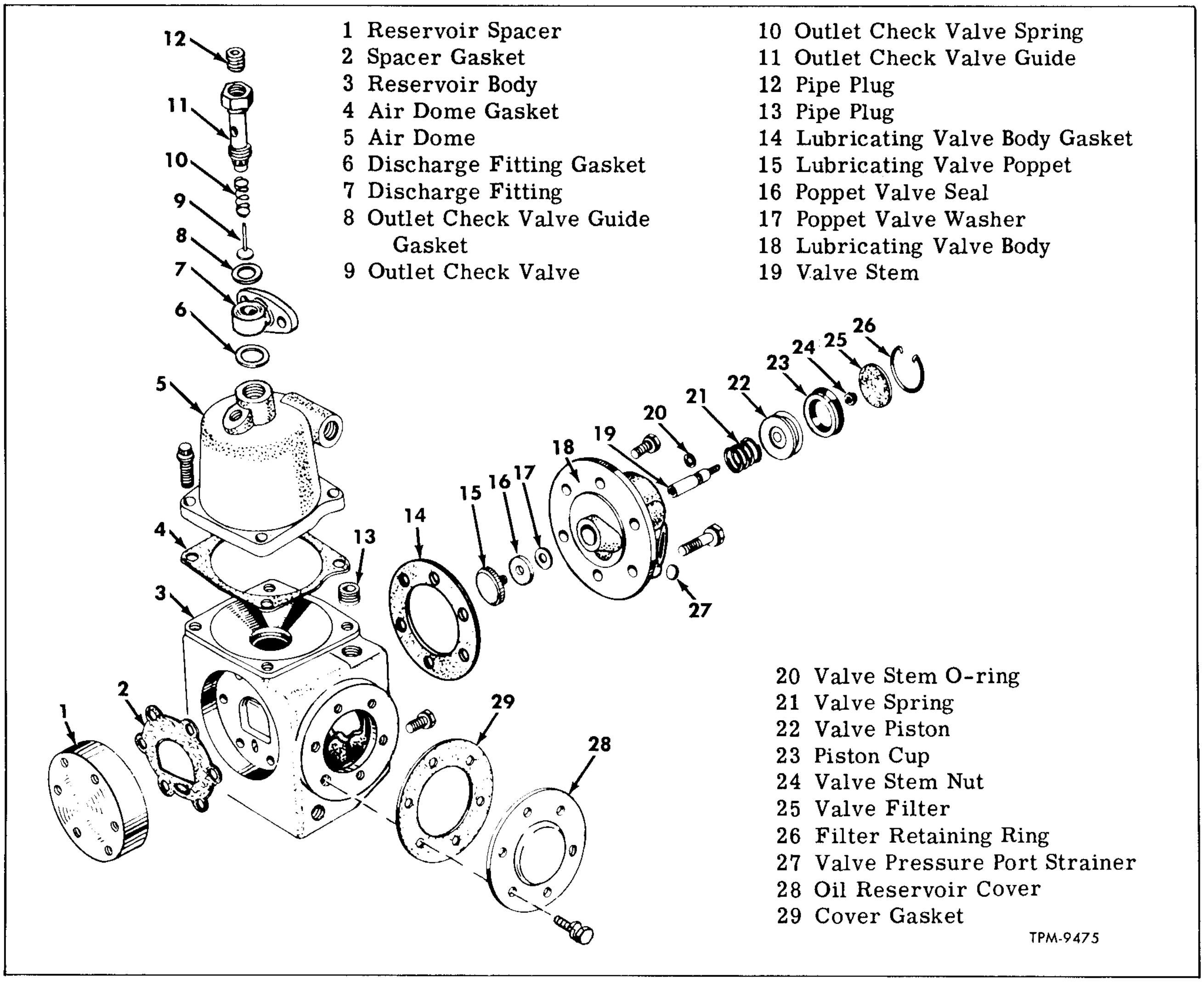


Figure 6—Air Dome, Reservoir, and Lubricating Valve Components

restriction orifice in lubricating valve body pressure port and in dome relief tube port are open.

2. Discard gaskets (4, 6, 14), poppet valve seal (16), valve stem O-ring (20), and piston cup (23) and obtain new parts for assembly.

3. Make sure check valve seat in air dome, poppet seal seat on lubricating valve body, and piston bore in lubricating valve body are clean and smooth.

4. Check tension of springs (10 and 21) against "Specifications" at end of this section. Replace springs not within specified limits.

ASSEMBLY

1. Dip all internal parts of lubricating valve assembly (15 through 23) in oil (same as used in engine). Place seal (16) and washer (17) over stem of lubricating valve poppet (15), making sure seal is fully seated in counterbore in poppet. Thread poppet into end of valve stem (19). Install O-ring seal (20) in groove in valve stem.

2. Install piston cup (23) in groove in piston (22) with lip of cup away from the deep recess on the spring side of the piston. Insert valve stem through lubricating valve body from inner side, then install valve spring (21) and piston assembly in body bore and over valve stem. Install nut (24) on valve stem. While holding knurled edge of poppet with pliers, tighten nut to 25 inch-pounds. Make sure valve stem and piston move freely in valve body. Install filter (25) in valve body and secure in place with retaining ring (26).

3. Using a new gasket (14), install lubricating valve assembly on reservoir and attach with six cap screws (2 long, 4 short). Tighten cap screws firmly.

4. Install gasket (8), discharge fitting (7), and gasket (6) over outlet check valve guide (11). Insert outlet check valve spring (10) and check valve (9) into valve guide. Insert valve guide into top of air dome and thread into place. Discharge fitting flange must be toward the compressor discharge tube port when valve guide is tightened.

5. Using new gasket (4), install air dome assembly on reservoir and attach with four special cap screws. Tighten cap screws firmly.

AIR COMPRESSOR OVERHAUL

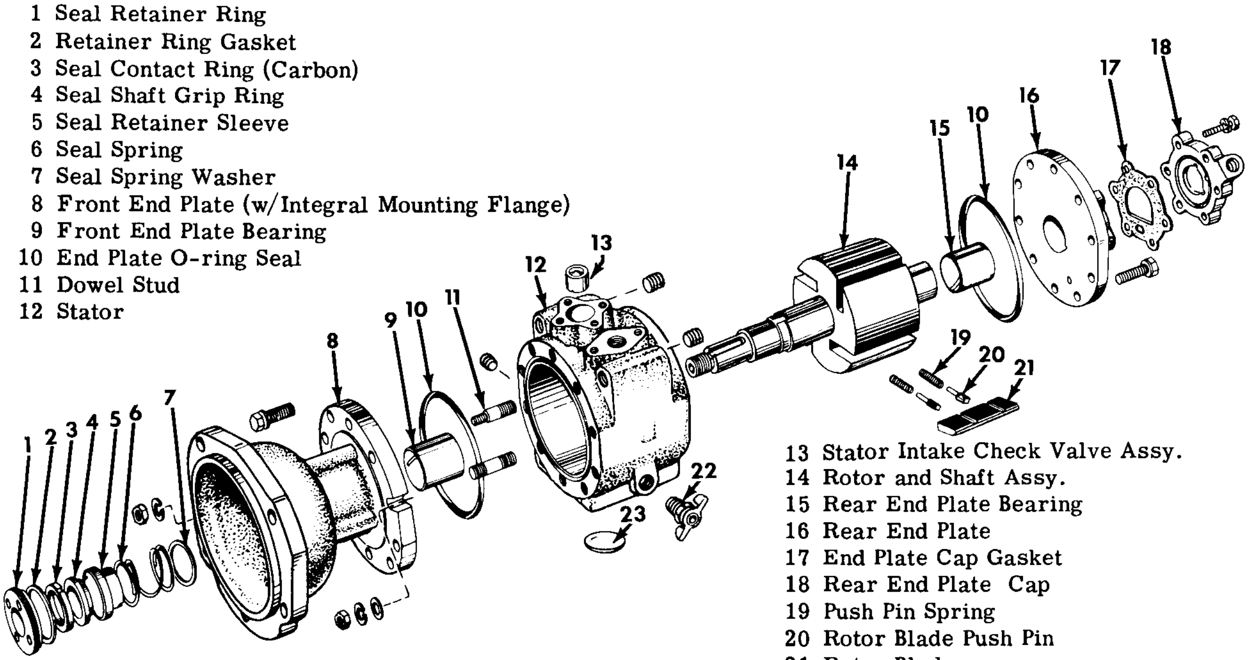
(Key Numbers in Text Refer to Figure 7, Unless Otherwise Indicated)

DISASSEMBLY

1. Install two 3/8-16 x 3 cap screws in two tapped holes in bottom of stator. Mount in vise with vise jaws gripping the cap screws.

2. If air dome and reservoir assembly and control valve assembly have not been removed, remove as follows.

1 Seal Retainer Ring
2 Retainer Ring Gasket
3 Seal Contact Ring (Carbon)
4 Seal Shaft Grip Ring
5 Seal Retainer Sleeve
6 Seal Spring
7 Seal Spring Washer
8 Front End Plate (w/Integral Mounting Flange)
9 Front End Plate Bearing
10 End Plate O-ring Seal
11 Dowel Stud
12 Stator



13 Stator Intake Check Valve Assy.
14 Rotor and Shaft Assy.
15 Rear End Plate Bearing
16 Rear End Plate
17 End Plate Cap Gasket
18 Rear End Plate Cap
19 Push Pin Spring
20 Rotor Blade Push Pin
21 Rotor Blade
22 Stator Drain Cock
23 Expansion Plug

TPM-9472

Figure 7—Air Compressor Components

a. Remove tubes (4, 5, 7, 8, and 10, fig. 4).

b. Remove nuts and lock washers from six studs attaching mounting plate (9, fig. 4) to compressor. Remove mounting plate and dome and reservoir assembly.

c. Remove two cap screws and lock washers attaching control valve assembly to compressor stator. Remove control valve assembly and gasket (3 and 2, fig. 4) from stator.

3. Lift stator intake check valve assembly (13) out of intake bore in top of stator.

4. Using a punch, mark relationship of rear end plate (16) to stator (12), end plate cap (18) to end plate (16), and mark location of the six double end studs used to attach the reservoir mounting plate so these parts can readily be reassembled in correct position.

5. Remove cotter pin and nut from end of rotor shaft, then pull drive hub off shaft, using a suitable puller. Remove spacer from rotor shaft.

6. Remove eight cap screws attaching front end plate (8) to stator. Remove nut and washer from two studs (11), but do not remove studs from stator. Separate end plate from stator and pull end plate with seal components off rotor shaft.

7. Using a spanner wrench (AL74), remove seal retainer ring (1) from end plate bore, then remove balance of seal components (2 through 7).

8. Lift rotor and shaft assembly out of stator, then remove rotor blades (21), push pins (20), and springs (19).

9. Remove six cap screws attaching rear end plate cap (18) to rear end plate, then remove cap and gasket (17).

10. Remove six double end studs and lock washers, and four cap screws attaching rear end plate (16) to stator. Separate end plate from stator, then remove O-ring seal (10) from groove in each end of stator.

11. It is not necessary to remove the end plate bearings (9 and 15) from end plates unless replacement is necessary as indicated later under "Cleaning, Inspection, and Repair."

CLEANING, INSPECTION, AND REPAIR

Cleaning. Wash all parts thoroughly in cleaning solvent and wipe dry. Blow out internal passages in stator and in rear end plate cap.

Inspection.

1. Discard the following parts and obtain new parts for assembly: All seal components (1 through 7, except spring 6); O-ring seals (10), and gasket (8).

2. Inspect intake check valve assembly (13) for free action, condition of spring, and condition of valve seat. Replace assembly if damaged in any way.

3. Inspect inner surfaces of end plates (8 and 16), bore of stator (12), and ends and outer diameter of rotor (14) for evidence of wear. Do not reuse these parts if wear marks can be felt with finger nail. Minor wear marks can be polished out.

4. Check condition of bearing surfaces on rotor shaft and of bearings (9 and 15) in end plates. Slide end plates over shaft ends in operating position and check shaft to bearing clearance against limits listed in "Specifications" at end of this section. If clearance is excessive, replace bushings as directed under "Repair."

Repair.

1. Press bearings out of end plates, using special arbor (AL52).

2. When installing new bearings, position bearings with oil grooves facing the rotor. Use installing arbor and guide sleeve (AL52 and AL51) to press new bearings into place. Avoid shaving metal from outer diameter of bearings while pressing in. If rotor shaft fits the new bearings too snugly, pass burnishing bar (AL53) through bearings one time only.

ASSEMBLY

1. Place O-ring seal (10) in groove in front end of stator. Assemble front end plate (8) to stator and install eight end plate to stator cap screws. Install nuts and washers on the two end plate to stator studs. Tighten cap screws and nuts finger-tight only.

2. Stand stator and end plate on end with end plate down. Insert rotor and shaft, without blades, into the stator, placing a 0.001-inch shim (1 inch wide) the full length of the rotor between the rotor and stator, midway between the intake and discharge ports. Shift the end plate position as necessary to solidly pinch the feeler shim, tapping end plate lightly to shift its position. Tighten end plate cap screws and stud nuts firmly, then turn rotor to remove shim.

3. With rotor seated against front end plate, use a straight-edge across top of stator to check rotor-to-end-plate clearance. Total clearance is listed in "Specifications" at end of this section. Also drop rotor blades into slots in rotor against front end plate, and again using straightedge across stator, measure blade-to-end-plate clearance against limits listed in "Specifications."

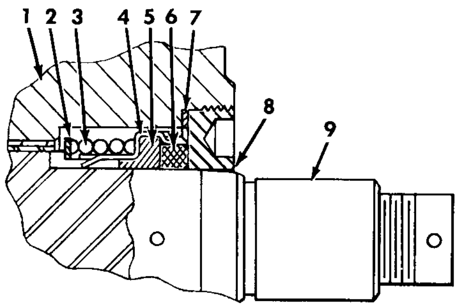
4. Lift rotor and shaft out of stator, then install two cap screws in bottom of stator and install in vise with the vise jaws gripping the cap screws.

5. Coat inner faces of end plates, end plate bearings, and rotor and shaft assembly with engine oil.

6. Assemble rotor blades (21), push pins (20), and push pin springs (19) in slots in rotor. Use rubber band or O-ring seal to hold blades in place while inserting shaft and rotor into the stator.

7. Install O-ring seal (10) in groove in rear

ROTARY AIR COMPRESSOR



1 Front End Plate
2 Seal Spring Washer
3 Seal Spring
4 Seal Retainer Sleeve
5 Seal Shaft Grip Ring
6 Seal Contact Ring (Carbon)
7 Retainer Ring Gasket
8 Seal Retainer Ring
9 Rotor Shaft TPM-9468

Figure 8—Rotor Shaft Seal Components Installed

end of stator, then install rear end plate over shaft and position against stator with marks made prior to disassembly aligned. Attach end plate to stator with four cap screws and six double end studs with lock washers. Be sure studs are located in correct holes (as marked prior to disassembly) so the reservoir mounting plate will be correctly positioned. Tighten cap screws and studs firmly.

8. Install rotor shaft seal components (1 thru 7) over rotor shaft and into front end plate in the order shown in figure 7. Seal components installed are shown in figure 8. Use spanner wrench (AL74) to tighten seal retainer ring (1) to 125 foot-pounds torque.

9. Install gasket (17) and cap (18) on rear end plate, with marks made prior to disassembly aligned. Attach cap to end plate with six cap screws. Tighten cap screws firmly.

10. Install stator intake check valve (13) in intake bore in top of stator, and install drain cock (22) in side of stator.

11. Install dome and reservoir and mounting plate assembly, control valve assembly, and interconnecting tubes, referring to figure 4 for proper position of fittings.

SPECIFICATIONS

Make	Wagner Electric Corp.
Type	CLR-12-WF
Capacity	12 cu. ft. per min.
Clearances	
Rotor to Stator (top center)	0.00075″-0.00100″
Rotor to End Plate (total, both ends)	0.0045″-0.0055″
Blade to End Plate (total, both ends)	0.0025″-0.0035″
Bearing to Shaft	0.0010″-0.0018″
Diameters	
Rotor Shaft O.D.	1.2488″-1.2493″
End Plate Bearing I.D.	1.2503″-1.2506″
Springs—Load Length and Load	
Rotor Shaft Seal Spring	½″ at 25-27.5 lbs.
Dome Outlet Check Valve Spring	⅜″ at 4-5 oz.
Relief Valve Piston Spring	17/32″ at 1.75-1.92 lbs.
Control Valve Pressure Regulating Spring	1 11/16″ at 45.6-50.4 lbs.
Lubricating Valve Piston Spring	13/32″ at 14⅛-15⅞ lbs.
Air Pressure Setting	
Cut-out Pressure	117-120 psi.
Cut-in Pressure (not adjustable)	15-20 psi. below cut-out

Parking Brake

Parking brake shoes are mounted on rear axle differential housing carrier as illustrated in figure 1. Parking brake is two-shoe, internal-expanding type. Brake lever is located at left side of driver. Parking brake lever is connected to an adjustable lever on brake camshaft by a series of rods and idler levers as shown in figure 2. Movement of brake lever rotates camshaft and forces brake shoes outward against brake drum. Brake drum is bolted to rear axle pinion companion flange.

PARKING BRAKE SHOES

Flanges on rear axle pinion bearing cage form the brake spider for brake shoes. Shoes pivot at one end on anchor pins which are retained in brake spider by lock screws and lock wire. Snap rings fit in grooves in ends of anchor pins to hold oil seal felts and retainers in place. Anchor pin ends of brake shoes are equipped with replaceable bushings. Cam end of each shoe is fitted with a roller which forms contact between brake shoes and cam. Roller pins for rollers are retained in shoes with set screws. One-piece lining is riveted to each brake shoe.

PARKING BRAKE CAMSHAFT

Camshaft is mounted at one end in a bushing in differential carrier housing, and at the other end in a bushing in parking brake spider (pinion bearing cage). Lubrication fitting in differential carrier housing supplies lubricant to both bushings. Oil seal in brake spider prevents passage of lubricant into brake drum. Adjustable lever is retained on splined end of camshaft by a flat washer and snap ring.

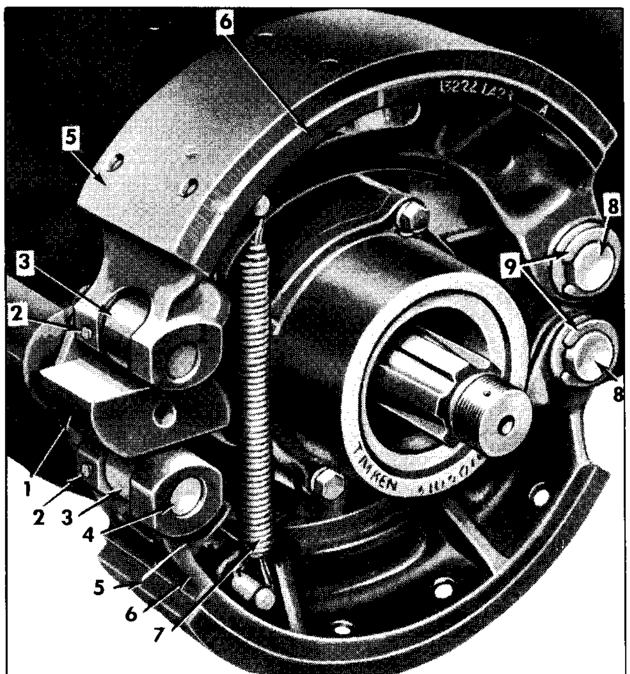
PARKING BRAKE ADJUSTMENT

Adjustment for normal brake lining and drum wear is made with adjustable lever (fig. 3). Before adjusting brake, check the following linkage dimension: Two levers are located one above the other in a bracket on bulkhead near parking brake. Center of upper lever clevis pin (fig. 2) should be from 3.16" to 3.19" away from bulkhead. Adjust nut on opposite side of bulkhead, if necessary, to obtain this dimension.

1. Place parking brake lever in fully released position.
2. Clean all dirt and grease from adjustable lever.
3. Measure clearance between brake shoe lining and brake drum with feeler gauge.
4. If clearance exceeds 0.015" by an appreciable amount, turn adjustable lever adjusting bolt until clearance is reduced to 0.015".
5. Move brake lever to applied position. Movement of two or three notches from completely released position should be sufficient to give full parking brake application.

BRAKE SHOE REMOVAL

1. Remove brake drum by performing applicable steps under "Propeller Shaft Removal" in PROPELLER SHAFT (SEC. 18) of this manual.
2. Remove brake shoe return spring.
3. Remove snap rings, oil seal retainers, and oil seals from ends of anchor pins.
4. Cut lock wire; then loosen anchor pin set screws. Drive anchor pins out of brake spider and remove brake shoes.



1 Camshaft
2 Set Screw
3 Roller
4 Roller Pin
5 Brake Lining
6 Brake Shoe
7 Brake Shoe Return Spring
8 Anchor Pin
9 Anchor Pin Lock

TP 0995-1

Figure 1—Parking Brake Shoes Installed

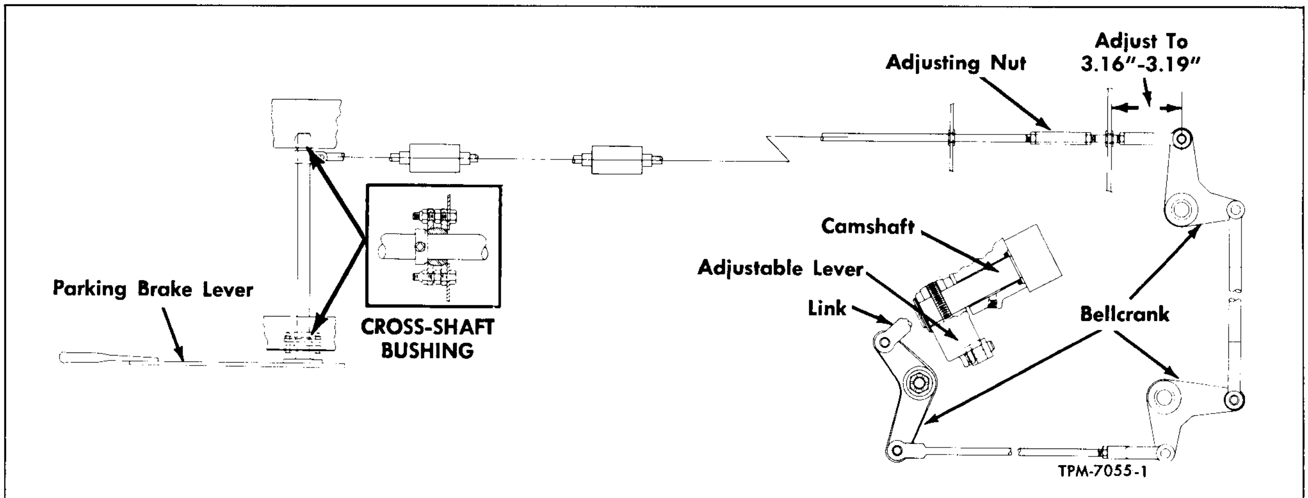


Figure 2—Parking Brake Control Linkage

BRAKE SHOE INSPECTION

1. Inspect brake lining and replace if worn down close to rivet heads. When making replacement, be sure brake lining fits firmly against brake shoe.
2. Examine anchor pin bushings in brake shoes and replace if worn excessively. After new bushings are installed, burnish to size listed in "Specifications" at end of this section.
3. Check brake shoe anchor pins for wear and replace if necessary.
4. Test brake shoe return spring for proper tension. Replace if weak or broken.
5. Examine rollers in brake shoes for wear or flat spots. Replace if not in good condition.

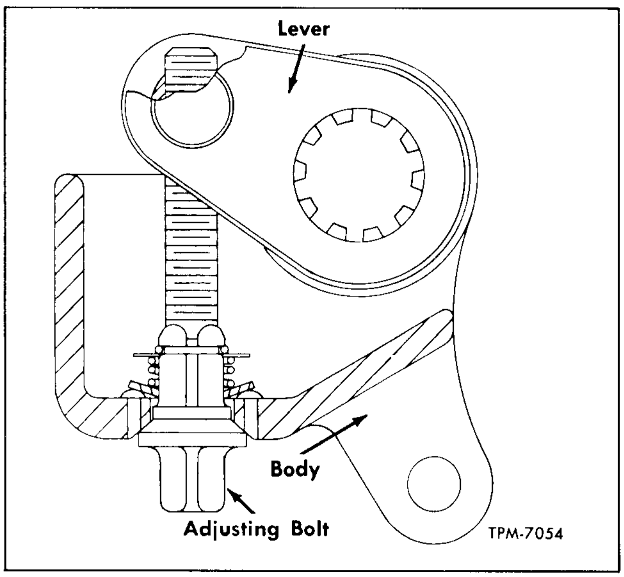


Figure 3—Parking Brake Adjustable Lever

6. Inspect brake shoe contact surface of brake drum for wear, scoring, or out-of-round. Refinish or replace drum as required.

BRAKE SHOE INSTALLATION

1. Coat brake shoe anchor pins and bushings with grease.
2. Place brake shoes on brake spider and install anchor pins. Anchor pins must be installed with milled flats aligned with set screw holes in brake spider.
3. Install new oil seals, seal retainers, and new snap rings on ends of anchor pins. Install anchor pin set screws, tighten firmly; then wire set screw heads together.
4. Install brake shoe return spring. Coat cam and brake shoe rollers sparingly with chassis grease.
5. Install brake drum and propeller shaft as directed in applicable steps under "Propeller Shaft Installation" in PROPELLER SHAFT (SEC. 18) of this manual.
6. Adjust brake as previously directed under "Parking Brake Adjustment" in this section.

CAMSHAFT REMOVAL

If necessary to remove camshaft, follow instructions previously given in steps 1 and 2 under "Brake Shoe Removal," then proceed as follows:

1. Remove propeller shaft flange from differential pinion shaft.
2. Disconnect link assembly from adjustable lever. Remove snap ring and washers securing adjustable lever on camshaft; then slide lever off camshaft.
3. Pull camshaft straight out through brake

spider. Do not lose spacing washer used between adjustable lever and differential carrier housing.

CAMSHAFT INSPECTION

1. Examine camshaft bushings in brake spider (pinion bearing cage) and in differential carrier housing. If worn excessively, install new bushings. After installing new camshaft bushings, burnish to correct size shown in "Specifications" at end of this section.

2. Inspect camshaft oil seal in brake spider and replace if wear, or deterioration is evident. When installing new oil seal, lip of seal must point inward toward bushing.

3. Examine camshaft and replace with new part if cam is scored or worn, or if shaft diameter is appreciably less than original diameter.

CAMSHAFT INSTALLATION

1. Coat camshaft and camshaft bushings with grease.

2. Insert splined end of camshaft through brake spider and differential carrier housing; be careful not to damage camshaft bushings or oil seal in brake spider.

3. Position brake shoes against cam; then install brake shoe return spring.

4. Make sure camshaft is turned so brake shoe rollers are resting on low points on cam. Place spacing washer over splined end of camshaft.

5. Place adjustable lever on camshaft in the position permitting connecting link assembly with least possible movement of camshaft.

6. Install washers and snap ring to secure adjustable lever on camshaft. Coat cam and brake shoe rollers sparingly with graphite grease.

7. Connect link assembly to adjustable lever. Install companion flange on differential pinion shaft.

8. Install brake drum and propeller shaft as directed in applicable steps under "Propeller Shaft Installation" in PROPELLER SHAFT (SEC. 18) of this manual.

9. Adjust brake as previously directed under "Parking Brake Adjustment" in this section.

PARKING BRAKE LINKAGE

(Refer to Figure 2)

Parking brake lever, located to left of driver, is attached to outer end of cross shaft. Cross shaft is solid and is supported at each end in permanently lubricated, self-aligning, bushing type bearings. Inner end of cross shaft carries a lever to which the front end of brake rod is connected. Brake rod incorporates spring type dampers and is connected to bell crank mounted on rear axle differential carrier housing. Bell crank is connected to an adjustable lever on camshaft by a link assembly and pins. Lubrication fittings are provided for idler levers and hand brake bell cranks. All other moving parts should be lubricated with oil can.

LUBRICATION

Periodic lubrication is required at the following points: Camshaft, brake shoe rollers and cam, bell crank, idler levers, hand lever, and all clevis connections in brake linkage. Refer to LUBRICATION (SEC. 13) for recommended intervals, type of lubricant, and method of application. Anchor pins require lubrication only at installation, using lubricant specified in LUBRICATION (SEC. 13). Whenever hand brake rods have been removed from loom, inside of loom must be lubricated, as directed in LUBRICATION (SEC. 13), before reinstalling rods.

Refer to next page for "Specifications."

PARKING BRAKE

SPECIFICATIONS

Type	Two-Shoe Internal-Expanding
Location	On Rear Axle Differential Carrier
Brake Drum Inside Diameter	12″
Shoe Lining	
Length (Each shoe)	11½″
Width	4½″
Thickness	½″
Area (both shoes)	104 sq. in.
Brake Shoe Return Spring	
Free Length	7″
Length at 27-33 Lbs. Pull	7¹¹⁄₁₆″
Cam Roller In Shoe	
Roller Outside Diameter	1.248″-1.252″
Roller Inside Diameter	0.771″-0.776″
Roller Pin Diameter	0.748″-0.749″
Camshaft and Bushings	
Shaft Diameter (at Bushings)	1.243″-1.245″
Bushing Inside Diameter (burnish in place)	
In Brake Spider	1.249″-1.251″
In Differential Carrier Housing	1.249″-1.251″
Anchor Pins and Bushings	
Pin Diameter (at Bushings)	0.996″-0.994″
Pin Length	2⅞″
Bushing Diameter	
Inside (burnish)	0.998″-1.000″
Outside	Must Be Tight in Shoe
Bushing Length	0.470″-0.490″
Diameter of Hole in Shoe	1.0615″-1.0630″
Brake Lever Bushing	
Inside Diameter	0.875″-0.876″
Outside Diameter	1.064″-1.065″
Width	1.710″-1.730″

Clutches

This group is divided into two sections as shown in the following Index. Specifications for each type clutch are included at end of respective clutch section. Wet type clutch is used on coaches with 6V-71 engines and dry type is used with 8V-71 engines.

Clutch and Controls
(WET TYPE CLUTCH)

DESCRIPTION AND OPERATION

CLUTCH

Clutch (figs. 1 and 2) is a single-speed, two-plate, wet disc type, with manually controlled disengagement and engagement by foot operated pedal and linkage (fig. 6). Clutch driven disc assemblies are splined to a drive flange, which in turn is splined to transmission pinion shaft. Two facings are bonded to each driven disc, which are held tightly between friction surfaces of spacer plate, pressure plate, and flywheel when clutch is engaged.

CLUTCH CONTROLS

Clutch is manually controlled by foot-operated clutch pedal, linkage, rods, and levers as illustrated in figure 6. Pedal cross shaft is mounted in self-aligning bearings. Control rods are enclosed within a loom and extend rearward through cross members under coach floor to engine compartment bulkhead. On Suburban ("S") models intermediate levers (fig. 6) are used to provide clearance under floor. Rear end of longitudinal control rod is connected to a bellcrank at engine compartment bulkhead. A transverse control rod connects bellcrank at engine compartment to clutch release lever. Clutch release lever is held in engaged position by a release lever return spring. Linkage adjustments are provided by adjustable yoke at end of control rod, while clutch release bearing clearance adjustment is accomplished by an adjusting nut at upper end of clutch release lever.

FLUID SYSTEM

The clutch and transmission are pressure lubricated by an engine driven fluid pump, mounted on engine. Fluid is picked up from transmission sump pan by the pump and delivered to the transmission bearing cap assembly on the end of the angle drive case. A disposable type oil filter is mounted on transmission. Oil pressure is controlled by a pressure regulator valve in bearing cap. A low oil pressure sending alarm switch is also located in bearing cap. Refer to TRANSMISSION (SEC. 17) for additional lubrication information and for overhaul procedure on fluid pump.

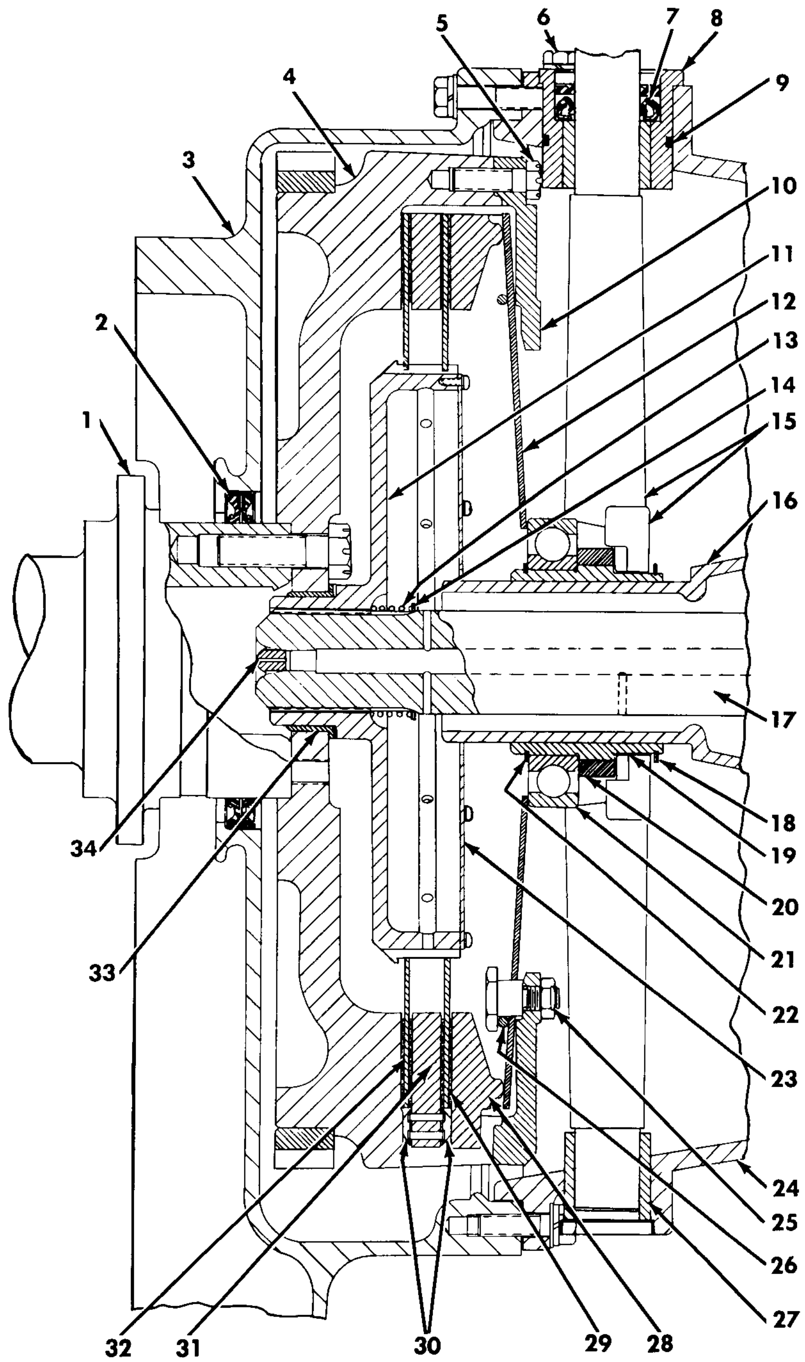
CLUTCH OVERHAUL

CLUTCH AND RELEASE MECHANISM REMOVAL

Key numbers in text refer to figure 1 except as otherwise indicated.

1. Remove transmission assembly as instructed in TRANSMISSION (SEC. 17) in this manual.
2. Remove spring and washer (8 and 9, fig. 3) from transmission drive pinion.
3. Remove release bearing and support assembly from transmission bearing cap (13, fig. 3).
4. Remove cap screw and lock washer attaching release shaft bushing flange to clutch housing. Remove flange assembly from clutch housing by forcing release shaft endwise. Remove flange from shaft, then remove shaft from housing.
5. Remove twelve bolts (5) attaching cover plate and spring assembly to flywheel, then remove cover plate assembly (10) and pressure plate (28).
6. Remove outer driven disc assembly (29), spacer plate and spring assembly (31), and inner

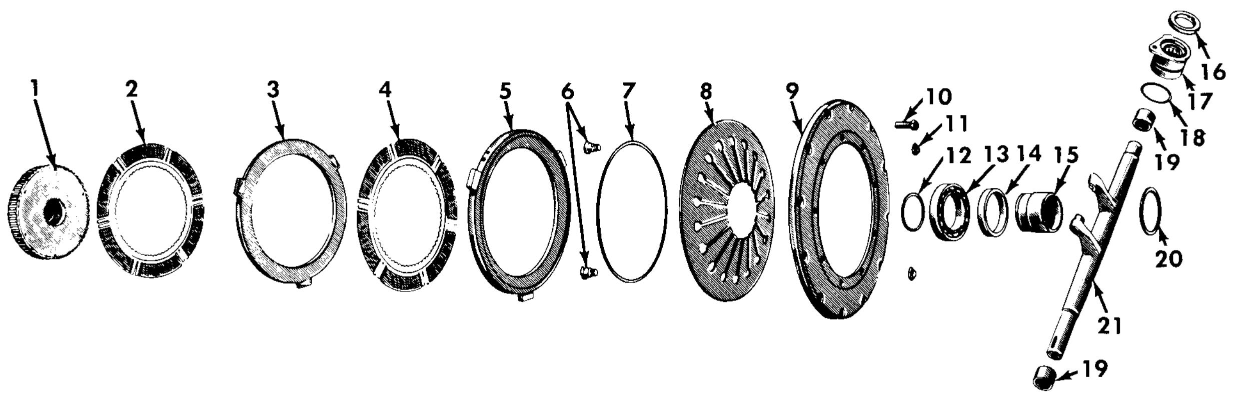
WET TYPE CLUTCH AND CONTROLS



1 Crankshaft
2 Crankshaft Oil Seal
3 Flywheel Housing
4 Flywheel
5 Cover Plate Bolt
6 Flange Bolt
7 Shaft Oil Seal
8 Shaft Flange
9 Seal Ring
10 Cover Plate
11 Drive Flange Assembly
12 Clutch Spring
13 Flange Spring
14 Spring Seat Washer
15 Release Shaft
16 Pinion Bearing Cap
17 Drive Pinion
18 Inner Snap Ring
19 Release Bearing Retainer
20 Retainer Ring
21 Release Bearing
22 Outer Snap Ring
23 Plate (Part of Flange Assy., Item 11)
24 Clutch Housing
25 Fulcrum Ring Bolt and Nut
26 Fulcrum Ring
27 Shaft Bushing
28 Pressure Plate
29 Driven Disc (Outer)
30 Spacer Plate Spring
31 Spacer Plate Assy.
32 Driven Disc (Inner)
33 Flywheel Bushing
34 Restricted Fitting

TPM-9263

Figure 1—Sectional View of Wet Type Clutch



1 Drive Flange	8 Clutch Spring	15 Bearing Retainer
2 Clutch Disc and Facing (Inner)	9 Clutch Cover Plate	16 Seal Assembly
3 Spacer Plate and Spring Assy.	10 Cover Plate Bolt	17 Flange
4 Clutch Disc and Facing (Outer)	11 Fulcrum Ring Bolt Nut	18 Seal Ring
5 Pressure Plate	12 Snap Ring (Outer)	19 Shaft Bushing
6 Fulcrum Ring Bolts	13 Release Bearing	20 Snap Ring (Inner)
7 Fulcrum Ring	14 Retainer Ring	21 Release Shaft TPM-9264

Figure 2—Wet Type Clutch Components

driven disc assembly (32) from drive flange assembly (11).

7. Remove drive flange assembly (11) from flywheel.

NOTE: The cover plate (10) and spring (12) need not be separated unless inspection indicates a need for replacing worn or damaged parts.

CLEANING AND INSPECTION

CLEANING

Clean all clutch components and clutch release parts before inspecting for wear or damage. Clutch drive facings should not be immersed in cleaning solvent but other parts should be cleaned by soaking to dissolve all accumulated oil and foreign matter. Clean the clutch disc facings by wiping with a clean cloth dampened with cleaning solvent.

INSPECTION

Before deciding to reinstall clutch parts, carefully inspect them for wear, fractures and other damage.

Key numbers in text refer to figure 2.

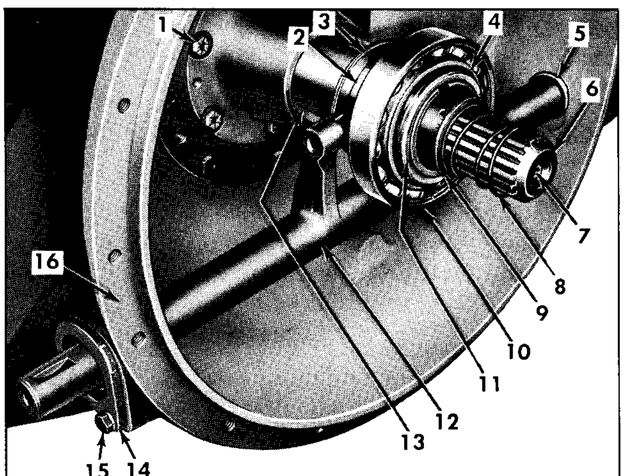
Clutch Spring and Cover Plate

Carefully inspect clutch spring (8) for evidence of worn, cracked, or broken fingers. Inspect outer edge of spring for fractures and for warpage.

Inspect clutch cover plate (9) and bolts (10). Bolt nuts must all be tight and cover plate must be in good condition.

Pressure Plate and Spacer Plate

Inspect surfaces on spacer plate (3) and pressure plate (5) which are contacted by driven disc



1 Bearing Cap Bolt	8 Spring
2 Retainer Ring	9 Washer
3 Retainer Inner Snap Ring	10 Release Bearing
4 Retainer Outer Snap Ring	11 Bearing Retainer
5 Shaft Bushing	12 Release Shaft Assy.
6 Drive Pinion	13 Bearing Cap
7 Restriction Fitting	14 Flange
	15 Flange Bolt
	16 Clutch Housing TPM-9275

Figure 3—Release Mechanism in Clutch Housing

facings. If surfaces are scored or worn or if any warpage of either plate is noted, new parts should be obtained for use in assembling clutch.

Inspect the six springs riveted to spacer plate (3). Outer ends of springs which contact flywheel and pressure plate (5) should all be 0.300 inch from surface of spacer plate (3). If necessary, carefully bend springs to obtain this dimension. If any of the springs are broken or excessively worn, remove rivets and install new springs. After installing springs make sure free ends of all springs are all same height (0.300 inch) above surface of spacer plate.

Clutch Driven Discs

Inspect facings on driven discs for wear. If wear has reduced thickness to 0.125 inch (0.045 wear at each member), install new members. Facings should be inspected for metal particles imbedded in surfaces which mate with driving members. Inspect six pairs of tabs on driven discs. Outer end of six tabs project inward and six project outward. Extreme ends of tabs should be 0.010 to 0.020 inch beyond surface of adjacent facing.

Facings at each side of disc must be flat within 0.017 inch total indicator reading.

Drive Flange

Inspect teeth or splines on drive flange (1) which engage driven discs, and inspect internal splines at hub which mate with transmission drive pinion. If wear is excessive the drive flange assembly should be replaced.

Also inspect surface of drive flange hub which contacts flywheel bushing (33, fig. 1). Surface should not be scored or worn.

Flywheel Assembly

Inspect flywheel surface which is contacted by clutch disc facing. If surface is scored or excessively worn, flywheel must be replaced.

Inspect bushing (31, fig. 1) installed in bore at center of flywheel. Replace bushing if worn or scored. Bushing original I.D. is 2.188 to 2.189 inches when installed. Inspect for wear where drive spacer plate and pressure plate lugs contact flywheel drive slots.

REPAIR

CLUTCH COVER PLATE AND SPRING

If inspection shows clutch cover plate or spring to be defective, follow procedure given below to disassemble and rebuild the clutch cover plate and spring assembly.

Refer to figure 5 for views of cover and spring assembly.

1. While holding fulcrum ring bolt heads with wrench, loosen each nut one turn at a time to relieve spring pressure gradually. When pressure is relieved, remove nuts from bolts and separate parts.

2. To assemble clutch cover plate and spring components proceed as follows:

a. Lay spring and fulcrum ring on cover plate with bolt holes in spring aligned with holes in cover. Concave side of spring must be toward fulcrum ring.

b. Insert nine special bolts through spring and cover plate with bolt heads engaging fulcrum ring. Install nuts on fulcrum ring bolts with knurled side of nuts exposed. Before tightening nuts be sure spring is exactly centered on cover plate, then tighten bolt nuts progressively around cover plate, one turn at a time.

c. Final tighten nuts to 15 to 20 ft. lbs. while holding bolt head with one of the points located over fulcrum ring as shown in figure 5.

CLUTCH AND RELEASE MECHANISM INSTALLATION

Soak driven disc facings in clean S.A.E. 30 Heavy Duty engine oil before assembly. Lubricate all parts with same oil during assembly operation.

1. Install drive flange with hub in flywheel bushing (fig. 4), then place inner disc on drive flange.

2. Place center spacer plate against inner disc as shown in figure 4.

3. Place outer disc on drive flange and against center spacer plate, then set pressure plate against outer disc with drive lugs engaging slots in flywheel (fig. 5).

4. Lift cover plate and spring assembly into place at flywheel and start twelve cover plate-to-flywheel bolts. Tighten cover plate bolts evenly to apply pressure uniformly and prevent distortion of cover plate. Tighten cover plate bolts to 35 to 40 ft. lbs. with torque wrench.

5. From inside clutch housing, pass lever end of clutch release shaft out through shaft flange opening, then move shaft endwise and into bushing (5, fig. 3). Install oil seal (7, fig. 1) in shaft flange and place seal in groove in flange. Cover keyway in shaft with tape, then assemble flange over end of release shaft and into clutch housing. Install bolt (15, fig. 3) and lock washer to secure flange to housing.

6. With clutch release bearing, retainer ring, and inner and outer snap rings assembled to retainer (11, fig. 3) start retainer and release bearing assembly on transmission bearing cap (16, fig. 1). Turn bearing retainer so milled flats are aligned with levers which are integral with release

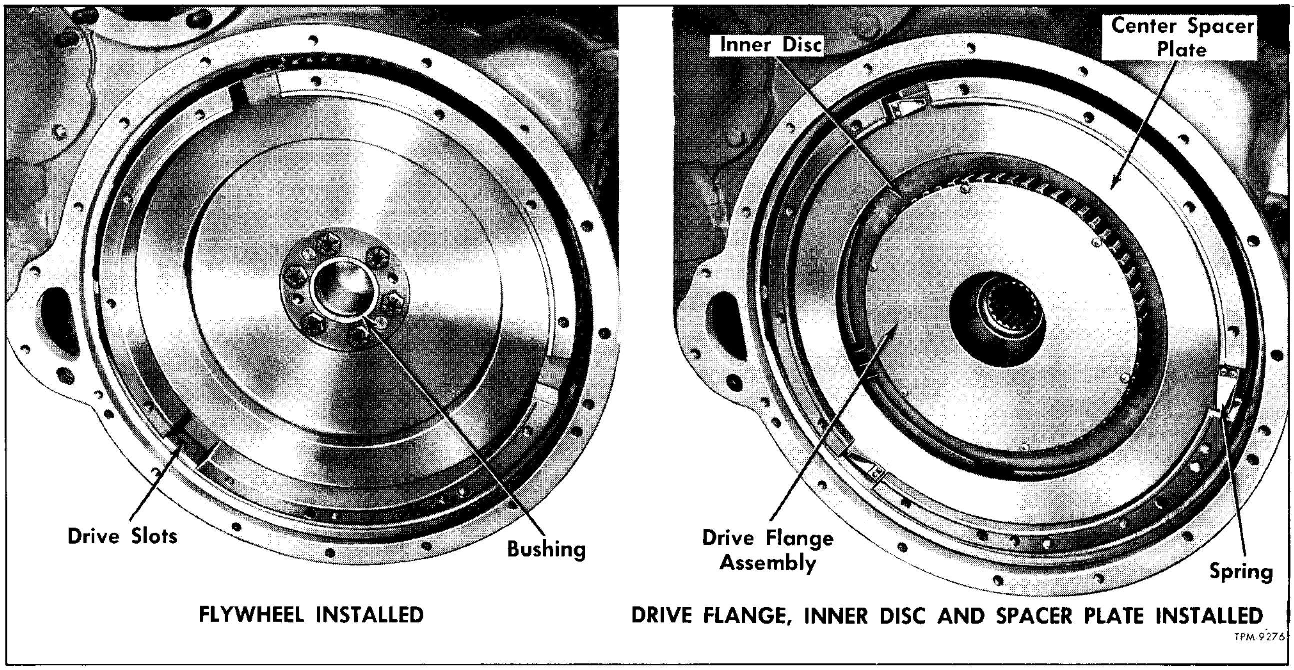


Figure 4—Flywheel and Clutch Installation Views

shaft. Engage ends of levers between ring and inner snap ring (2 and 3, fig. 3) as retainer and bearing assembly is pushed onto transmission bearing cap.

7. Install washer (spring seat) and spring (9 and 8, fig. 3) on transmission drive pinion. Figure 3 shows mechanism assembled in clutch housing.

8. Install transmission as instructed in TRANSMISSION (SEC. 17) in this manual.

CLUTCH CONTROLS

Clutch is manually controlled by clutch pedal which is connected to clutch release lever in engine compartment by the levers and rods shown in figure 6. Rods are inclosed in waterproof loom where exposed to road splash. Bellows-type seals are used at ends of loom to exclude dirt and moisture.

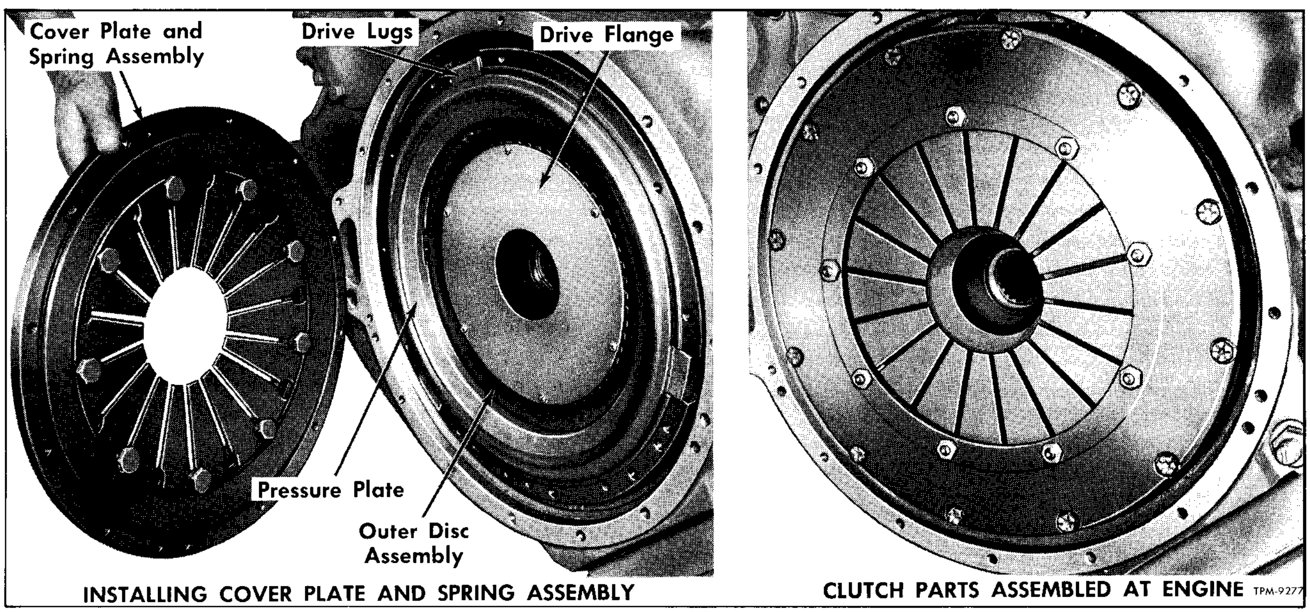
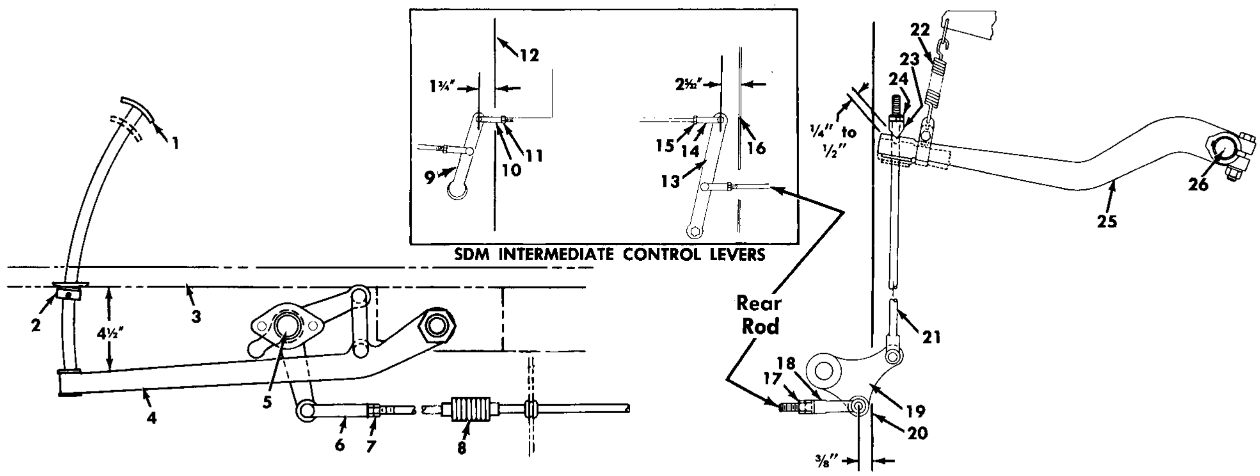


Figure 5—Installing Clutch Cover Plate and Spring Assembly

WET TYPE CLUTCH AND CONTROLS



1 Clutch Pedal
2 Adjustable Collar
3 Floor Board
4 Pedal Lever
5 Cross Shaft
6 Adjustable Yoke
7 Lock Nut
8 Boot (Seal)
9 Intermediate Lever - Front
10 Adjustable Yoke
11 Lock Nut
12 Body Bulkhead - Front Wheelhouse
13 Intermediate Lever - Rear
14 Adjustable Yoke
15 Lock Nut
16 Body Bulkhead - Rear Wheelhouse
17 Lock Nut
18 Adjustable Yoke
19 Control Bell Crank - Rear
20 Body Bulkhead - Engine Compartment
21 Rear Control Rod
22 Return Spring
23 Adjustment Nut
24 Lock Nut
25 Clutch Release Lever
26 Clutch Release Shaft

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Figure 6—Clutch Control Linkage

CLUTCH CONTROL ADJUSTMENTS

AT FRONT END (ALL MODELS)

Key numbers in text refer to figure 6.

1. Check distance from pedal lever (4) to underside of floor. Distance should be 4-1/2 inches at point indicated in figure 6.

2. If necessary to change position of pedal lever in relation to floor, first check return spring (22) which must be in good condition and check to see that adjustable collar (2) is held firmly against floor. Loosen set screw in collar (2) and move collar as required to provide the 4-1/2-inch dimension from pedal lever to floor. Tighten set screw.

AT INTERMEDIATE LEVERS (SDM MODELS ONLY)

When clutch control rods or other linkage on SDM coaches is replaced or if difficulty is experienced in clutch linkage operation, perform check and make adjustment if necessary, at the intermediate control levers as directed below. Inset in figure 6 shows lever arrangement.

1. Make sure return spring (22) is holding clutch pedal collar (2) up against floor and be sure the pedal lever-to-floor dimension is correct as explained previously in "At Front End" adjustment.

2. Dimension from center of upper clevis pin in lever (9) is 1-3/4 inches from body bulkhead (12). Should adjustment be necessary, turn adjustable clevis (6) on front end of rod to obtain above dimension.

3. Either of the two procedures (a and b) given below can be used to determine if rear intermediate lever (13) is in correct position.

a. Block the clutch pedal in fully released position with pedal pad against the floor. At engine compartment bulkhead measure distance from bulkhead to center of clevis pin in rear control rod bell crank lever (19). If this dimension is 1-5/8 inch to 1-7/8 inch, the rear intermediate lever (above fuel tank) is correctly adjusted.

b. Remove access cover from opening in aisle side riser to provide view of levers and rods as shown in figure 7. With clutch pedal released, measure distance from center of clevis pin in upper end of clutch rear idler lever to bulkhead. Correct dimension is 2-5/32 inches.

4. If the procedure described in step 3 above indicates need for adjustment, turn clevis (14, fig. 6) to set lever in proper position.

NOTE: After changing the setting at intermediate levers follow the procedure described under "At Rear End" to assure correct setting at clutch

control rear bell crank.

AT REAR END (ALL MODELS)

For proper leverage and satisfactory clutch linkage operation, the distance from clevis pin in lever (19, fig. 6) to bulkhead is 3/8 inch as shown.

1. With clutch pedal up (collar contacting floor), measure distance from center of clevis pin at bell crank (19, fig. 6) to bulkhead.

2. If necessary loosen lock nut, remove clevis pin, and turn adjustable yoke (18) to provide the 3/8 inch dimension shown in figure 6.

ADJUSTMENT FOR NORMAL WEAR
(IN ENGINE COMPARTMENT)

As normal wear occurs at clutch facings, it becomes necessary to make the adjustment described below to provide clearance at clutch release bearing and insure proper clutch action.

NOTE: Need for linkage readjustment for wear will be indicated by point at which maximum load is noted at clutch pedal. Only the clutch control linkage is adjustable. The clutch itself cannot be adjusted.

Key numbers in text refer to figure 6.

1. If maximum pedal load occurs when pedal pad is less than one inch from floor, or if when checking free movement at lever (25) it is found that there is less than 1/4 inch of lever free movement when lever is pushed away from adjusting nut, adjustment at nut (23) is necessary. Maximum load point is easily determined by the "feel" of the clutch pedal.

2. Loosen lock nut (24) to permit turning of adjusting nut (23).

a. If maximum pedal load occurs when pedal is more than 1-1/2 inches above floor, turn adjusting nut (23) counterclockwise (as viewed from transmission side of engine compartment).

b. If maximum pedal load occurs when pedal is less than one inch from floor, turn adjusting nut (23) clockwise toward lever.

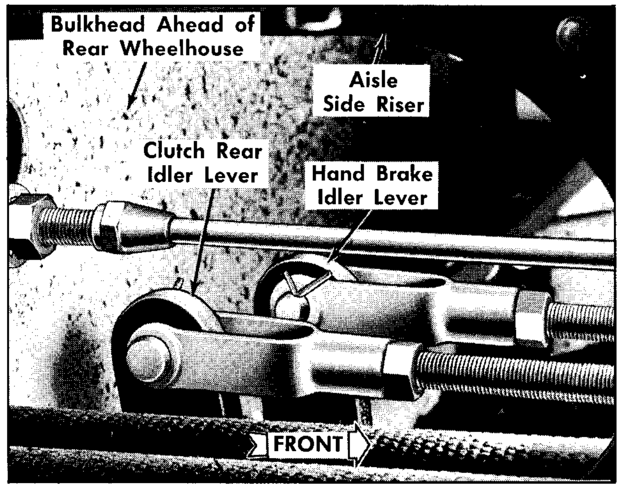


Figure 7—Clutch Control Rear Idler Lever as Seen Through Access Opening in Aisle Side Riser

3. Lock the adjusting nut (23) with lock nut (24), making sure the wedge on adjusting nut is aligned with notches in lever (25).

4. Start engine, and check to determine that clutch release can be obtained. If not, the trouble lies in the main clutch area and not the clutch adjustment. This is expected to occur when clutches are excessively worn or when there is interference of some kind in the clutch area.

NOTE: The feel of clutch pedal when applying or releasing clutch is somewhat different from the feel with standard clutches. This is normal and does not indicate improper clutch operation.

5. Finally try pushing lever (25) away from adjusting nut (23), and note the distance lever can be moved freely. There should be at least 1/4 inch of free movement; if lever cannot be moved freely 1/4 to 1/2 inch there is a danger of damage to release bearing caused by insufficient space between the bearing assembly and clutch release fingers (spring).

SPECIFICATIONS

CLUTCH SPACER PLATE	
Thickness	0.498"-0.502"
Flat Within	0.006" T.I.R.
Surfaces Parallel Within	0.002" T.I.R.
Width of Lugs	1.742"-1.744"
CLUTCH PRESSURE PLATE	
Thickness	0.921"-0.916"
Flat Within	0.006" T.I.R.
Width of Lugs	1.742"-1.744"
CLUTCH DRIVE FLANGE	
Hub Diameter at Flywheel Bushing	2.183"-2.185"
FLYWHEEL BUSHING	
Inside Diameter	2.188"-2.189"
CLUTCH PLATE AND FACING	
Thickness	0.167"-0.173"
Flat Within	0.017" T.I.R.
TORQUE SPECIFICATIONS	
Diaphragm Spring to Cover Bolt Nuts	15-20
Cover Plate to Flywheel	30-35

Clutch and Controls
(DRY TYPE CLUTCH)

DESCRIPTION

Clutch used with 8V-71 Diesel engine is two-plate dry disc type shown in figures 1 and 2. An intermediate (center) drive plate is installed between the two clutch discs, the hubs of which are splined to transmission pinion gear shaft. The three projections on center plate engage notches in flywheel.

Coil springs between clutch cover and pressure plate provide positive engagement of clutch members. Springs exert pressure on pressure plate, and thence to rear driven disc, intermediate driving plate, forward driven disc, and flywheel face.

Figures 3, and 6 show the clutch release linkage. Clutch release is affected by pedal, the movement of which is transmitted to release mechanism through rods and levers shown in figure 3.

Release mechanism in engine compartment consists of an air valve assembly, air cylinder assembly and interconnecting air lines (fig. 4).

In clutch housing the clutch release bearing and support assembly is actuated by cross shaft and yoke shown in figure 10.

OPERATION OF AIR-ASSISTED CLUTCH RELEASE MECHANISM

Key numbers in text refer to figure 6 unless otherwise indicated.

Initial movement of clutch pedal exerts pull on rod (2), and since there is no resistance to initial movement of lever (20), the lever moves until release bearing contacts clutch release lever buttons (23, fig. 2).

With release bearing against clutch release levers, the pull on rod (2) is increased as clutch pedal is depressed further. When the pull on rod (2) exceeds 40 pounds, the pull rod and lever in valve (4) are moved and actuate piston, which in turn closes exhaust valve and begins to open air inlet valve.

With inlet valve open in control valve (4), air from supply line (7) passes into line (11) and into air cylinder (2). Air pressure acting on cylinder piston exerts pressure through piston rod, clevis, and clevis pin (18) which connects clevis to release lever (20). Since air cylinder is anchored to stationary bracket (14), piston continues to assist in movement of release lever (20) so long as a pull in excess of 40 pounds is applied through rod (2). As cylinder piston rod moves outward, air ahead of piston is exhausted through breather (10).

As soon as the air pressure in cavity beside the valve piston and in cylinder (12) is sufficient to overcome the mechanical force which is applied to valve piston by actuating lever, the piston moves toward actuating lever and permits air inlet valve to seat. This prevents any additional rise in air pressure in cylinder, and since the exhaust valve remains closed, the air pressure remains stable in cylinder and clutch linkage remains stationary.

When driver wishes to engage clutch and clutch pedal is released, the reduced pull on rod (2) causes a reduction in mechanical force acting on valve piston, consequently the air pressure in cylinder and at piston forces piston back to released position, at which time the exhaust valve is opened and air pressure in cylinder (12) is released. Clutch spring pressure moves pressure plate into engagement with driven members, at the same time release lever (20) moves toward cylinder (12), exhausting air from cylinder through air line (11) and out exhaust port (2, fig. 4) in side of valve (4). As piston is forced into cylinder (12), atmosphere enters cylinder through breather (10).

Spring (15) holds lever (20) in contact with wedge-shaped end on adjusting nut (8) and causes release bearing to be held out of contact with clutch release levers. Spring supports air line (11) so it does not rub against other mechanism. Pedal return spring (8, fig. 3) holds pedal and linkage in engaged position when driver's foot is not on pedal.

CLUTCH CONTROL MAINTENANCE

CLUTCH PEDAL AND LINKAGE (Fig. 3)

1. Be sure all pivot points in control linkage are lubricated according to instructions given in LUBRICATION (SEC. 13).

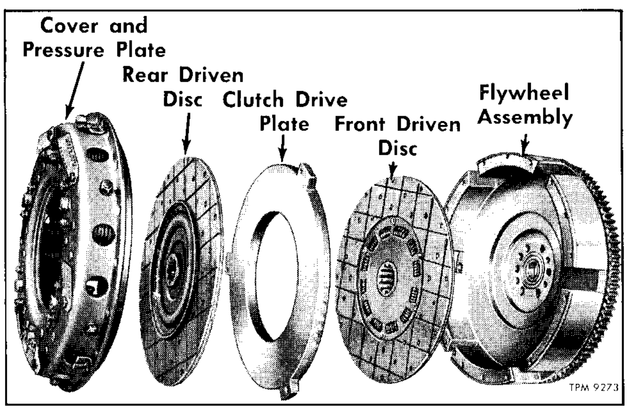
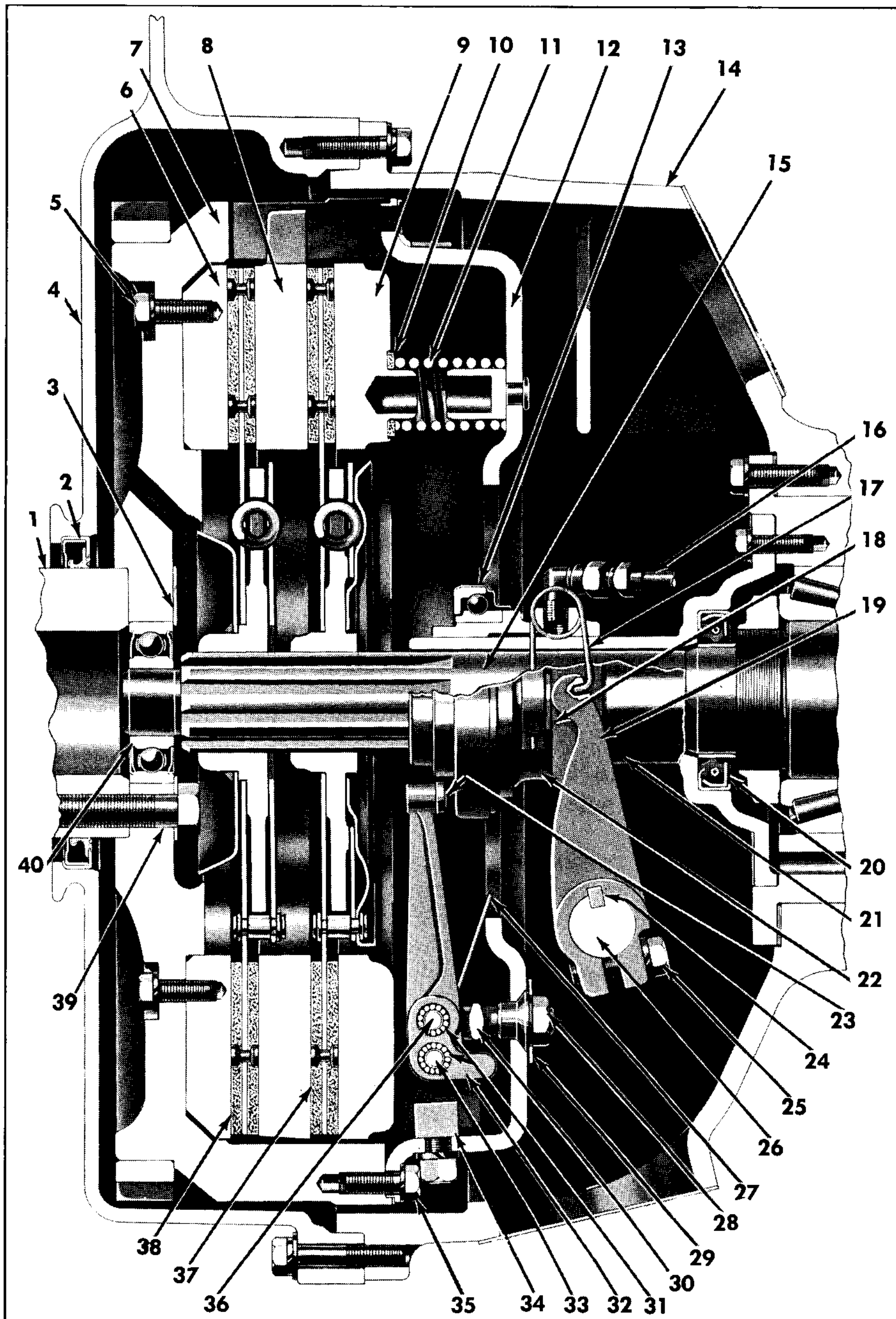


Figure 1—Dry Clutch Components

DRY TYPE CLUTCH AND CONTROLS



1 Engine Crankshaft
2 Crankshaft Oil Seal
3 Bearing Retainer
4 Flywheel Housing
5 Flywheel Plate Bolt
6 Flywheel Plate
7 Flywheel
8 Drive (Center) Plate
9 Pressure Plate
10 Spring Insulator
11 Pressure Spring
12 Clutch Cover
13 Release Bearing
14 Clutch Housing
15 Drive (Pinion) Gear
16 Lubrication Tube
17 Bearing Retracting Spring
18 Thrust Button
19 Clutch Release Yoke
20 Oil Seal
21 Transmission Bearing Cap
22 Release Bearing Support
23 Lever Thrust Button
24 Key
25 Clamp Bolt
26 Release Lever Shaft
27 Lever Spring
28 Yoke Adjusting Nut
29 Thrust Plate
30 Release Lever Yoke
31 Needle Bearing Rollers
32 Release Lever
33 Lever Pin
34 Drive Block
35 Cover Bolt
36 Yoke Pin
37 Rear Driven Disc
38 Front Driven Disc
39 Flywheel Bolt
40 Pilot Bearing

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Figure 2—Cross Section of Dry Type Clutch Installed

2. Check dimension between clutch pedal lever (4) and underside of floor. If necessary to provide the 4-1/2 inch dimension as shown, move the adjustable collar (2) which is held in place by set screw.

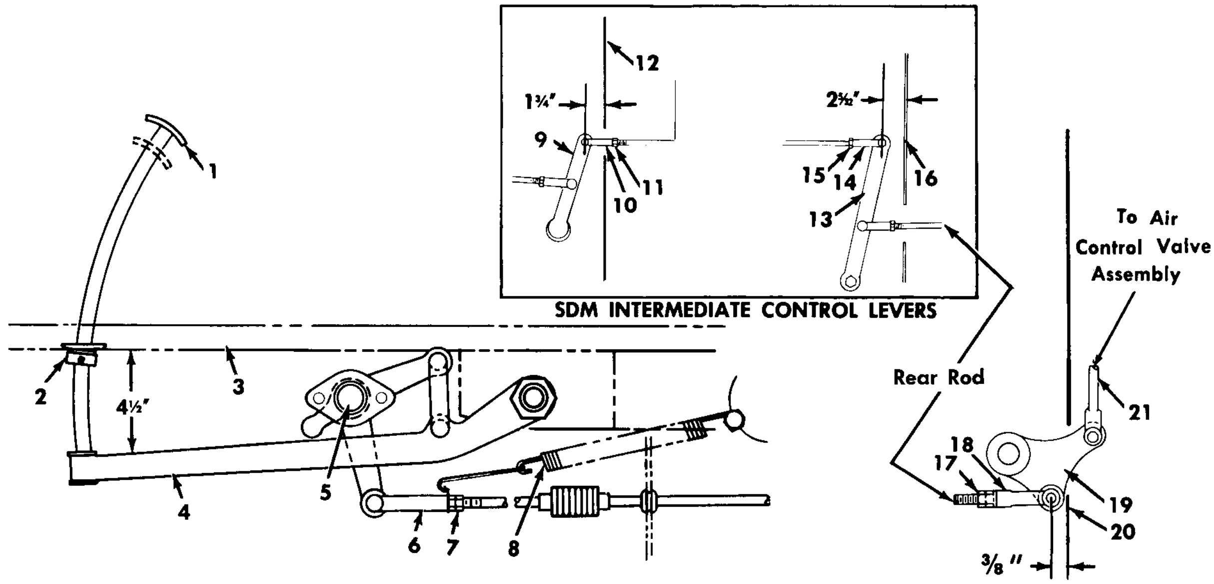
3. Always use return spring (8) as specified in Parts Book.

4. When replacing control rod, rod end clevises, or bell crank (19), adjust rod end clevises so that center of pin hole in bell crank (19) is distance from bulkhead shown in figure 3. This will give best leverage for disengaging clutch with light pedal pressure.

CAUTION: Always make adjustments as later described at linkage in engine compartment after replacing any items shown in figure 3.

CONTROL LINKAGE AND UNITS IN ENGINE COMPARTMENT

1. Make periodic inspection of air lines and



1 Clutch Pedal
2 Adjustable Collar
3 Floor Board
4 Pedal Lever
5 Cross Shaft
6 Adjustable Yoke
7 Lock Nut
8 Pedal Return Spring
9 Intermediate Lever - Front
10 Adjustable Yoke
11 Lock Nut
12 Body Bulkhead - Front Wheelhouse
13 Intermediate Lever - Rear
14 Adjustable Yoke
15 Lock Nut
16 Body Bulkhead - Rear Wheelhouse
17 Lock Nut
18 Adjustable Yoke
19 Control Bell Crank - Rear
20 Body Bulkhead - Engine Compartment
21 Rear Control Rod

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Figure 3—Clutch Pedal and Control Linkage

air line connections.

2. Referring to figure 6, check lock nut (5) on rod (6) at air valve (4). Lock nut must be kept tight to hold valve in position. There must be no twisting force on control valve plunger in either the engaged or disengaged position.

3. Lubricate pivot points in linkage as directed in LUBRICATION (SEC. 13).

4. At intervals specified on Lubrication Chart, remove pipe plugs (12, fig. 4) from both ends of air cylinder and introduce one ounce of engine oil into each end of cylinder. Refer to LUBRICATION (SEC. 13) for type and viscosity of oil to use.

5. At 50,000 mile intervals remove and discard air cylinder breather (10, fig. 4) and install new breather assembly.

6. Lubricate clutch release bearing and yoke shaft fittings in clutch housing as directed in LUBRICATION (SEC. 13) in this manual. Figure 10 shows clutch release mechanism in clutch housing.

7. Apply S.A.E. 10W engine oil at oiler (22, fig. 4) on valve assembly at intervals specified in LUBRICATION (SEC. 13).

CLUTCH CONTROL ADJUSTMENTS

AT FRONT END (ALL MODELS)

Key numbers in text refer to figure 3.

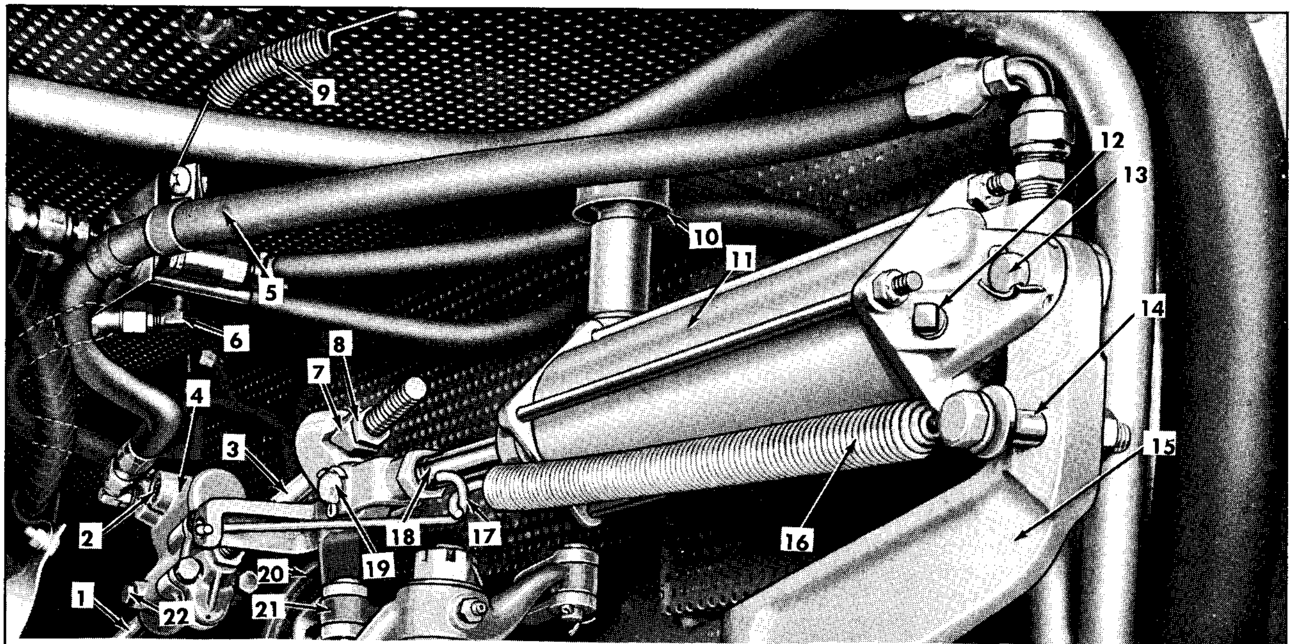
1. Check distance from pedal lever (4) to underside of floor. Distance should be 4-1/2 inches at point indicated in figure 3.

2. If necessary to change position of pedal lever in relation to floor, first check return spring (8) which must be in good condition and check to see that adjustable collar (2) is held firmly against floor. Loosen set screw in collar (2) and move collar as required to provide the 4-1/2-inch dimension from pedal lever to floor. Tighten set screw.

AT INTERMEDIATE LEVERS (SDM MODELS ONLY)

When clutch control rods or other linkage on SDM coaches is replaced or if difficulty is experienced in clutch linkage operation. Perform check and make adjustment, if necessary, at the intermediate control levers as directed below. Inset in figure 3 shows lever arrangement.

DRY TYPE CLUTCH AND CONTROLS



1 Clutch Release Rod	9 Spring	16 Clutch Lever Spring
2 Valve Exhaust Port	10 Air Cylinder Breather	17 Spring Extension
3 Valve-to-Lever Rod	11 Air Cylinder	18 Piston Rod
4 Air Control Valve	12 Lubrication Plug	19 Piston Rod Clevis Pin
5 Valve-to-Cylinder Air Line	13 Pin	20 Clutch Release Lever
6 Air Supply Line	14 Spring Anchor	21 1, 2, and Reverse Shift Lever
7 Adjusting Nut	15 Air Cylinder Bracket	22 Oiler
8 Lock Nut		TPM-9402-1

Figure 4—Air Cylinder and Control Valve Installed

1. Make sure return spring (8) is holding clutch pedal collar (2) up against floor and be sure the pedal lever-to-floor dimension is correct as explained previously in "At Front End" adjustment.

2. Dimension from center of upper clevis pin in lever (9) is 1-3/4 inches from body bulkhead (12). Should adjustment be necessary, turn adjustable clevis (6) on front end of rod to obtain above dimension.

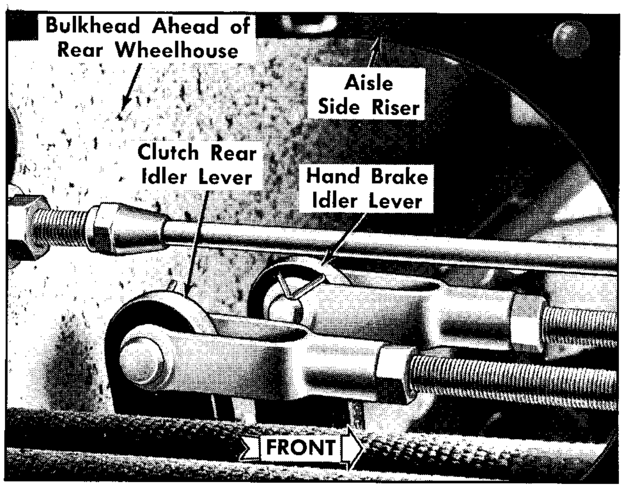


Figure 5—Clutch Control Rear Idler Lever as Seen Through Access Opening in Aisle Side Riser

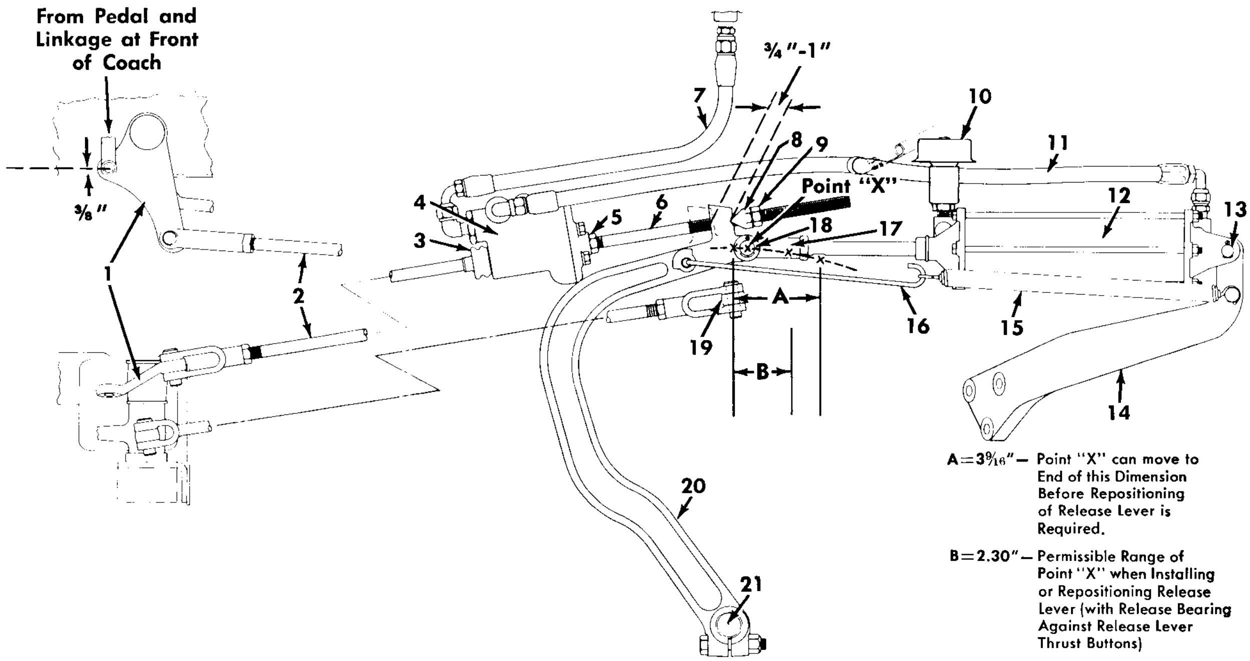
3. Either of the two procedures (a. and b.) given below can be used to determine if rear intermediate lever (13) is in correct position.

a. Block the clutch pedal in fully released position with pedal pad against the floor. At engine compartment bulkhead measure distance from bulkhead to center of clevis pin in rear control rod bell crank (19). If this dimension is 1-5/8 inch to 1-7/8 inch, the rear intermediate lever (above fuel tank) is correctly adjusted.

b. Remove access cover from opening in aisle side riser to provide view of levers and rods as shown in figure 5. With clutch pedal released, measure distance from center of clevis pin in upper end of clutch rear idler lever (13) to bulkhead. Correct dimension is 2-5/32 inches.

4. If the procedure described in step 3. above indicates need for adjustment, turn clevis (14, fig. 3) to set lever in proper position.

NOTE: After changing the setting at intermediate levers follow the procedure described under



1 Bellcrank
2 Bellcrank to Control Valve Rod
3 Valve Rod Boot
4 Air Control Valve
5 Lock Nut
6 Control Valve to Release Lever Rod
7 Air Supply Line
8 Adjusting Nut
9 Lock Nut
10 Air Cylinder Breather
11 Valve to Cylinder Air Line
12 Air Cylinder
13 Clevis Pin
14 Air Cylinder Bracket
15 Release Lever Return Spring
16 Return Spring Extension
17 Air Cylinder Rod Clevis
18 Clevis Pin
19 Transmission 1st, 2nd, and Reverse Lever
20 Clutch Release Lever
21 Clutch Release Yoke Shaft

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Figure 6—Clutch Control Mechanism in Engine Compartment

"At Rear End" to assure correct setting at clutch control bell crank.

AT REAR END (ALL MODELS)

For proper leverage and satisfactory clutch linkage operation, the distance from clevis pin in bell crank (19, fig. 3) to bulkhead is 3/8" as shown.

1. With clutch pedal up (collar contacting floor) measure distance from center of clevis pin at bell crank (19, fig. 3) to bulkhead.

2. If necessary loosen lock nut, remove clevis pin, and turn adjustable yoke (18) to provide the 3/8 inch dimension shown in figure 3.

ADJUSTMENT FOR NORMAL WEAR (IN ENGINE COMPARTMENT)

As normal wear occurs at clutch facings it becomes necessary to make the adjustment described below to provide clearance at clutch release bearing and insure proper clutch action.

RELEASE BEARING CLEARANCE ADJUSTMENT

Adjustment to compensate for normal clutch facing wear is made at the clutch release lever in engine compartment. This adjustment must be made when inspection indicates need for adjustment. The minimum of 3/4" free movement of release lever (fig. 6) must be maintained to assure clearance between release bearing and thrust buttons on clutch release levers, and to provide full disengagement of clutch when clutch pedal is near floor. Check and make adjustment as follows:

Key numbers in text refer to figure 6.

1. Unhook clutch lever spring (15).

2. Move lever (20) from point of contact with wedged end of nut (8) toward control valve (4). If lever free movement is not at least 3/4 inch shown in figure 6, make adjustment as instructed in step 3. below. Adjustment should be maintained as closely as possible to 3/4 to 1 inch to provide ideal clutch operation.

3. Loosen lock nut (9), and turn adjusting nut (8) as necessary to provide 3/4 to 1 inch free-travel of lever (20). Be sure wedge end of adjusting nut (8) is aligned with V-notch in release lever (20), then tighten lock nut. After tightening lock nut, recheck control valve for binding both in the engaged

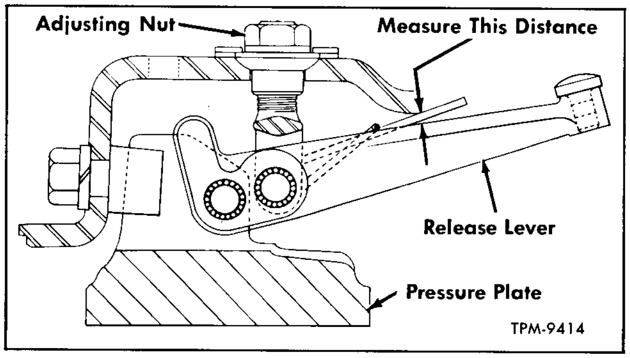


Figure 7—Point of Measurement For Resetting Release Levers

and disengaged positions. There must be no twisting force on valve plunger.

4. When adjustment is completed, install release lever spring and extension (15 and 16).

CAUTION: DO NOT use a substitute for spring (15) with tension greater than original spring. Also be sure extension (16) is not shorter than original part. Increasing the tension of spring will hold exhaust valve in control valve closed and trap air in air cylinder.

REPOSITIONING RELEASE SHAFT LEVER

As clutch facings wear, point "X" (fig. 6) normally moves toward air cylinder (13) with each succeeding release bearing clearance adjustment. This point, which is the centerline of clevis pin attaching air cylinder clevis to release lever, must be within the dimension shown for "A" in figure 6 when clutch is engaged. To determine if lever (20) should be repositioned, shift transmission in neutral, then measure distance from center of pin in lever (19, fig. 6) to point "X" when clutch is engaged. If the distance is more than 3-9/16 inches, release lever must be repositioned on release yoke shaft (21, fig. 6) as follows:

Key numbers in text refer to figure 6 unless otherwise indicated.

1. Place transmission gearshift lever in neutral, and unhook release lever return spring (15). Remove clevis pin which attaches clevis to release lever at point "X" and disengage clevis from lever (20).

2. Loosen clamp bolt securing release lever (20) to shaft (21), and mark lever (20) and end of shaft (21) to show original relationship.

3. Pry release lever (20) off shaft (21), move top of lever toward air control valve (4) one serration from original position as marked in step 2, and reinstall lever on shaft.

4. Check position of point "X" which must be within the dimension shown for "B" in figure 6, with release bearing contacting clutch release lever thrust buttons. Tighten release lever clamp bolt to 35 to 45 foot-pounds torque. Connect air cylinder rod clevis (17) to release lever (20) with clevis pin (18) and cotter pin.

5. Adjust release bearing clearance as previously instructed.

NOTE: Release lever (20) cannot repeatedly be repositioned. After lever has been repositioned once and normal wear has permitted point "X" to reach maximum limit as shown for dimension "A" on figure 6, it must be determined whether there is sufficient clearance between the clutch release levers (32, fig. 2) and clutch cover (12, fig. 2) to warrant repositioning lever again. This can be checked through opening in clutch housing after removing screened cover from housing (14, fig. 2). If clearance is less than 3/16 inch, new clutch disc and facing assemblies must be installed, unless release levers are reset as directed below under "Resetting Release Levers." After installing new facings, release lever will require repositioning toward air cylinder to bring point "X" within the dimension shown for "B" on figure 6.

RESETTING RELEASE LEVERS

If it is desired to completely wear out clutch facings, the clutch release levers can be reset once during the life of clutch. Check lever position and reset as directed below.

1. Through inspection hole in clutch housing measure distance from edge of clutch cover to lever at point indicated in figure 7.

2. With sharp tool mark one corner of one hex adjusting nut and the steel thrust plate. Unscrew adjusting nut exactly two turns, using markings for reference. Mark with paint to indicate lever has been reset (so that a second readjustment will not be made).

3. With starter, turn flywheel to bring next adjusting nut into view, then repeat step 2 until all 6 levers have been readjusted. Perform lever readjustment with care to maintain the lever "in-plane" condition.

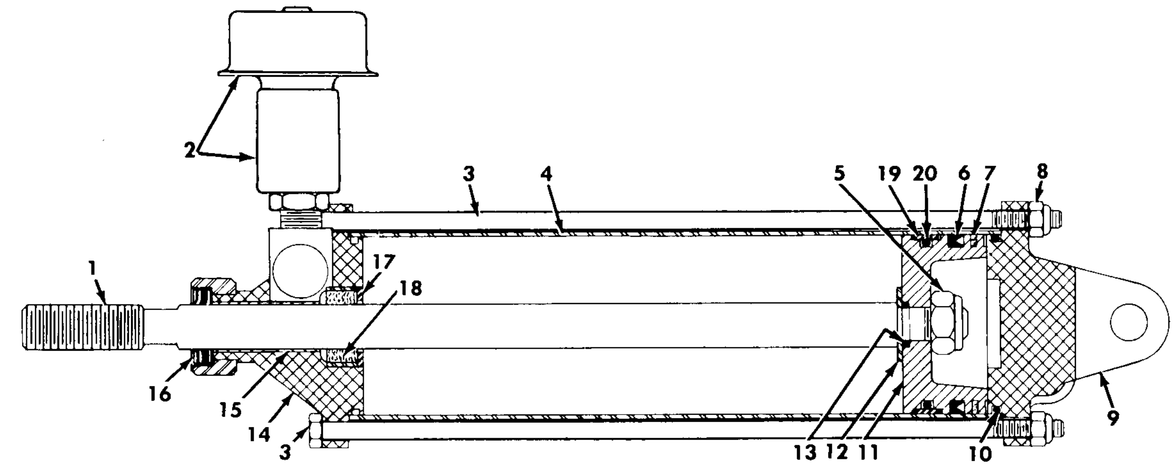
CAUTION: The foregoing procedure may be used only once during life of a set of clutch disc facings. When levers have been reset as directed above, mark the clutch assembly in some manner so a second resetting will not be made. If levers are reset a second time, damage will result from rivet heads contacting driving members.

4. Reposition release shaft lever to locate point "X" (fig. 6) within proper operating range. Refer to "Repositioning Release Shaft Lever" covered previously in this section.

CLUTCH RELEASE AIR CYLINDER

REMOVAL (Refer to Fig. 4)

1. Unhook and remove release lever return spring (16).



1 Piston Rod	8 Nut	15 Bushing
2 Breather Assembly	9 Rear Cover	16 Piston Rod Seal
3 Clamp Bolt	10 O-Ring Gasket	17 Felt Retainer
4 Cylinder	11 Piston	18 Felt
5 Piston Retaining Nut	12 Washer	19 Wiper
6 Piston Seal Ring	13 O-Ring Seal	20 O-Ring
7 Piston Felt	14 Front Cover	

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Figure 8—Clutch Release Air Cylinder

2. Disconnect air line (6) at air cylinder (11).
3. Remove pin (19) which attaches piston rod clevis to clutch release lever (20).
4. Remove pin (13) which attaches air cylinder assembly (11) to bracket (15), then remove cylinder assembly.
5. Remove yoke and lock nut from piston rod and cylinder.

DISASSEMBLY (Refer to Fig. 8)

1. Remove breather assembly (2) from cylinder front cover by using wrench on reducing bushing.
2. Remove nuts (8) from bolts (3) and remove bolts.
3. Remove end covers (9 and 14) and pull piston and rod assembly out of cylinder (4).
4. Remove O-ring (10) from rear cover (9). Pry seal retainer off front cover and remove piston rod seal (16). Remove felt retainer (17) and felt (18) from inner side of cover.
5. Remove piston felt (7) and seal ring (6) from piston (11). Remove wiper (19) and O-ring (20) from piston (11).
6. To remove piston (11) from piston rod (1), clamp rod in vise at flat areas and remove self-locking nut (5). Remove piston and O-ring (13) from rod, then remove washer (12).

CLEANING AND INSPECTION

Clean all parts thoroughly, then inspect each component carefully. If any of the parts are damaged, install new ones when assembling. A repair kit is available when overhauling air cylinder assembly.

ASSEMBLY (Refer to Fig. 8)

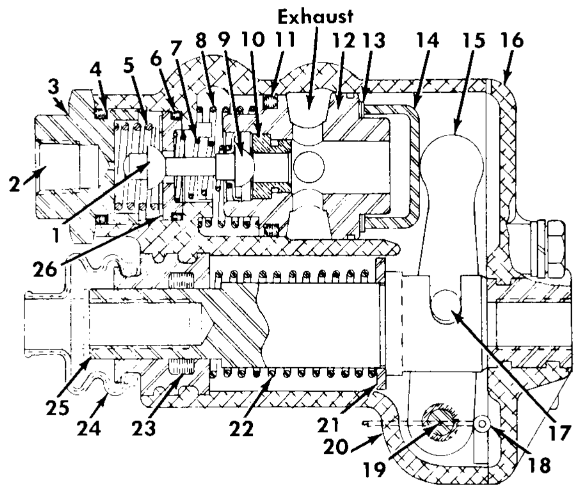
1. If piston has been removed from piston rod, grip rod (1) in vise at flat areas, then place washer (12) against shoulder on rod.
2. Locate O-ring (13) in counterbore in piston (11), then install piston on rod and install retaining nut (5). Tighten nut firmly. Install piston felt (7), and install seal ring (6) with lip toward felt (7). Install O-ring (20) and wiper (19) on piston (11).
3. Install piston rod seal (16) and retainer on front end cover (14). Install felt (18) and retainer (17) in inner side of front end cover. Place O-ring (10) in groove in rear cover. Apply a light coat of grease (MIL-G-3278A or equivalent) on piston and on inner surface of cylinder.

4. Insert piston rod through cylinder and carefully pull piston into cylinder. Be sure to guide seal ring and felt (6 and 7) and wiper (19) into cylinder without damage to these parts.

5. Install front and rear covers (14 and 9) on cylinder and install four clamp bolts and nuts (3 and 8).

NOTE: Threaded openings in both covers must face upward.

6. Remove pipe plug from rear cover (9) and put in one ounce of S.A.E. 10W engine oil. Install



1	Inlet Valve	14	Piston Seat
2	Air Supply Inlet Port	15	Actuating Lever
3	Inlet Valve Cap	16	Cover
4	Seal	17	Lever Pin
5	Retainer Spring	18	Cotter Pin
6	Valve Seat Seal	19	Fulcrum Pin
7	Valve Spring	20	Valve Body
8	Piston Spring	21	Washer
9	Exhaust Valve	22	Pull Rod Spring
10	Exhaust Valve Seat	23	Oiler Felt
11	Piston O-Ring Seal	24	Boot
12	Piston	25	Pull Rod
13	Shims	26	Inlet Valve Seat

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Figure 9—Air Control Valve

plug, then while turning cylinder, operate piston several times by hand to distribute oil evenly over all inner surfaces.

7. Bench test cylinder assembly for air leaks. Test can be made by connecting air supply at tapped hole in rear cover (9) and checking for air bubbles at breather port in front cover (14), and at end of cylinder where it seats at rear cover, with air pressure applied. Do not use air pressure in excess of 100 psi for testing. Use soap suds solution and brush.

8. Install breather assembly (2) in front cover.

INSTALLATION (Refer to Fig. 4)

1. Locate air cylinder assembly (11) at bracket (15) and install pin (13). Secure pin (13) with cotter pin.
2. Attach piston rod yoke to release lever (20) with clevis pin (19).
3. Connect air line (5) to fitting in rear cover.
4. Check clutch release linkage adjustments as previously directed under "Clutch Control Adjustments."
5. Install release lever return spring (16) and extension (17).

AIR CONTROL VALVE

REMOVAL

Key numbers in text refer to figure 4 unless otherwise indicated.

1. Exhaust air pressure from air system.
2. Disconnect and remove air lines (5 and 6).
3. Unhook and remove release lever return spring (16) and extension (17).
4. Disconnect bellcrank to control valve rod (1) from bellcrank (1, fig. 6). Remove lock nut (8) and adjusting nut (7) from control valve to release lever rod (3). Remove valve and rods as an assembly.
5. Unscrew rods (1 and 3) from control valve.
6. Remove boot (24, fig. 9) used to seal out dust and moisture at rod (1).

DISASSEMBLY

Key numbers in text refer to figure 9 unless otherwise indicated.

1. Remove snap ring from exhaust port (2, fig. 4), then remove cleaning material and retaining plates. Remove oiler (22, fig. 4) from valve body.
2. Remove end cover bolts, then remove end cover (16). Remove fulcrum pin (19) which is retained by cotter pin (18), then remove actuating lever (15) and pull rod (25).
3. Remove spring (22) and spring washer (21) from pull rod.
4. Remove piston seat (14) and shims (13).
5. Use wrench to remove inlet valve cap (3), then remove springs, spring seat, and valves (1 and 9).
6. Use a round rod to push piston assembly (12) out of body (19). Remove O-ring seal (11) from piston.

CLEANING AND INSPECTION

Thoroughly wash all parts of valve in cleaning solvent to remove all deposits of dirt.

Inspect each valve component for wear, corrosion, and other damage. Exhaust valve seat in piston must be in good condition.

ASSEMBLY

Key numbers in text refer to figure 9 unless otherwise indicated.

1. Using new seals (4 and 6) on inlet valve cap and inlet valve assembly (3 and 1), assemble valve assembly (1), spring (5), and cap (3) in valve body.
2. Install new piston O-ring seal (11) on piston (12), then place piston spring (8) in body (20). Lubricate piston O-ring (11) and piston bore with light coat of grease containing zinc oxide (#1) and insert piston assembly into body.

3. Oil the felt (23) with engine oil, then with spring washer and spring (21 and 22) on pull rod (25), assemble pull rod in body (20).

4. Place piston seat (14) on piston and temporarily install lever (15) in body with pin (17) engaged with notch in pull rod (25). Install fulcrum pin (19).

5. Install a stop plate across end of body using two cover bolts. (Plate to serve to locate pull rod (25) in normal operating position.) Connect an air supply line to air supply inlet port (2), and mount a dial indicator to measure distance piston seat (14) travels from released position to point at which inlet valve (1) opens. Opening of inlet valve will be indicated by sound of air at air delivery port. If indicator shows movement in excess of 0.030 inch, remove piston seat (14) and install shims (13) as required to reduce movement to 0.020 to 0.030 inch.

6. After shim selection is made, assemble cover (16) on valve body (20).

7. Install oiler (22, fig. 4) and install filter in exhaust port (2, fig. 4).

INSTALLATION

Key numbers in text refer to figure 4 unless otherwise indicated.

1. Place dust boot (24, fig. 9) on valve body, then screw rods (1 and 3) into control valve. A lock nut must be in place on rod (3) which is installed in the cover end of the valve.

2. Position valve and rod assembly at engine with rod (3) inserted through upper end of clutch release lever (20). Connect rod (1) at bellcrank (1, fig. 6).

3. Install adjusting nut (7) on rod (3). While holding lever (20) toward valve (4) to locate release bearing in contact with clutch levers, thread nut (7) to provide 3/4 to 1 inch between point of nut wedge and bottom of Vee in lever (20). Install spring (16) and extension (17), then install and tighten lock nut (8).

4. Connect air lines (5 and 6). Start engine and operate to build up pressure in air system. Perform tests described below after control valve is installed.

CONTROL VALVE LEAKAGE TEST

With air system charged to normal operating pressure, coat exhaust port (2, fig. 4) with soap suds and check for leakage. The check should be made both with the clutch released and with clutch engaged. If a three inch bubble forms in three seconds or less, leakage is excessive. Excessive leakage is caused by defective valves and/or valve seats, or air passing the piston O-ring seal.

CONTROL VALVE OPERATING TEST (Fig. 4)

Disconnect line (5) from valve (4) and install an air pressure gauge to register pressure at valve outlet port. Observe gauge as clutch pedal is depressed. Pressure on gauge should gradually increase as pedal force increases when pedal is moved from "Clutch Engaged" to "Clutch Disengaged" position.

CLUTCH REPLACEMENT

CLUTCH REMOVAL

Removing Cover Plate, Driven Discs, and Flywheel

Key numbers in text refer to figure 2.

Before removing clutch, transmission must be removed as instructed in TRANSMISSION (SEC. 17). Then proceed as follows:

1. Install six bolts (cap screws - 3/8"-16 x 2", threaded 1") through holes in cover plate (12) located directly above each release lever (32). Turn screws into pressure plate (9) as far as possible. This procedure relieves pressure spring (11) load so cap screws (35) can be easily removed.

2. Remove cover bolts (35), meanwhile supporting clutch. Tap flange of clutch cover with soft mallet to free assembly from flywheel. Remove clutch cover assembly, driven discs, and drive plate (8).

3. To remove pilot bearing (40), flywheel bolts (39) must be first removed as pilot bearing is retained by bearing retainer (3) which also serves as bearing plate for flywheel bolts. Remove flywheel and drive out pilot bearing assembly (40).

NOTE: If inspection shows flywheel plate (6) to be worn or damaged, the plate may be removed by removing twelve bolts (5) which attach plate (6) to flywheel (7). Refer to figure 1 for view of clutch components.

Release Mechanism Removal (Fig. 10)

1. Remove release lever from clutch release lever shaft (8). Remove cover plate from housing at opposite end of shaft.

2. Remove two springs (2) connecting release bearing sleeve to release yoke (10). Disconnect lubrication tube (5) from release bearing sleeve, then slide bearing and sleeve assembly (1) off end of transmission bearing cap (4).

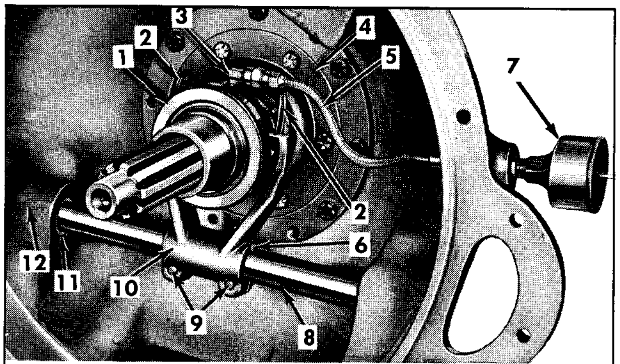
3. Remove two cap screws (9) from release yoke, then drive the yoke to one side to expose keys (6). Remove yoke keys and drive shaft (8) out of yoke and remove from housing.

CLUTCH INSTALLATION

Release Mechanism Installation

Key numbers in text refer to figure 10.

1. Hold clutch release yoke (10) in position in



1 Release Bearing and Support Assembly	6 Yoke Key
2 Release Bearing Spring	7 Grease Cup
3 Lubrication Elbow	8 Release Lever Shaft
4 Transmission Bearing Cap	9 Yoke Clamp Bolts
5 Lubrication Flexible Tube	10 Release Yoke
	11 Bushing
	12 Clutch Housing

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Figure 10—Release Mechanism in Clutch Housing

clutch housing (12), then insert release shaft (8) through right-hand bushing (11), through yoke (10), and into bushing at opposite side of clutch housing.

2. Install keys (6) in shaft (8), and move yoke into place with keys (6) engaging keyway in yoke. Do not tighten bolts (9) until after release bearing and support assembly (1) is assembled to bearing cap (4).

3. Install shaft cover plate at outer side of housing (12). Rotate shaft (8) so yoke (10) is in position shown in figure 10, install release bearing and support assembly (1) on bearing cap (4), and clip support to yoke with two release bearing springs (2). Connect lubrication flexible tube (5) to release bearing support.

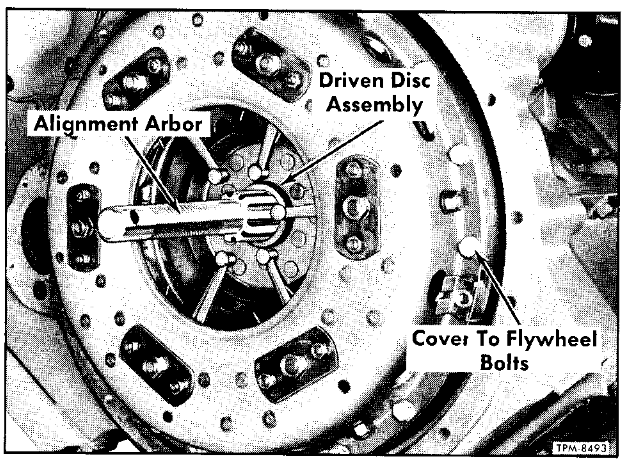


Figure 11—Clutch Cover Assembly Installed (Typical Aligning Tool Shown)

4. Check shaft (8) and yoke (10) to make sure they are properly centered, then tighten yoke clamp bolts (9).

5. Fill grease cup (7) with lubricant as specified in LUBRICATION (SEC. 13) and turn down cup to provide initial lubrication to bearing assembly. Apply a light coat of same lubricant on pilot surface on bearing cap (4). Also lubricate shaft bushings (11) through respective fittings.

Installing Flywheel, Cover Plate, and Driven Discs

Key numbers in text refer to figure 2 unless otherwise indicated.

1. If flywheel and/or pilot bearing have been removed, fill crankshaft cavity 1/3 full of pilot bearing lubricant - (high melting point 300°F. sodium soap grease).

2. Install pilot bearing (40) in flywheel (7), then install flywheel on crankshaft with holes for bolts (39) aligned. Place bearing retainer (3) at flywheel and install flywheel bolts. Tighten bolts evenly to 150 to 160 foot-pounds torque.

3. Place clutch disc marked "Flywheel Side" at flywheel.

CAUTION: The two driven discs are not interchangeable. Slingers on discs can be referred to for identification if markings are not legible. Disc having slinger with smaller diameter is front (flywheel) disc. Rear disc assembly has a larger slinger and is marked "Pressure Plate Side" (fig. 12). Slinger on front disc (38) must be toward flywheel and the slinger on rear disc (37) must be toward release levers (32).

4. Place drive (center) plate (8) in position at front driven disc.

NOTE: Install drive plate (8) with machined side of drive lugs toward transmission.

5. Locate rear driven disc (37) at plate (8), referring to "CAUTION" note above for correct identification of rear disc and proper position of slinger. Insert aligning arbor through driven disc hubs and into pilot bearing (40) to hold disc splines in alignment while cover assembly is being installed. Refer to figure 11.

6. Place clutch cover assembly at flywheel then install cover bolts (35) with new lock washers. Tighten bolts evenly and firmly.

7. If new clutch cover and pressure plate assembly is being installed, remove the six bolts (cap screws) with tags (fig. 12). Removal of bolts is necessary to allow pressure springs to operate.

NOTE: Bolts used at tag locations (fig. 12) must be removed when installing original or rebuilt clutch cover assembly.

8. After performing the foregoing procedures,

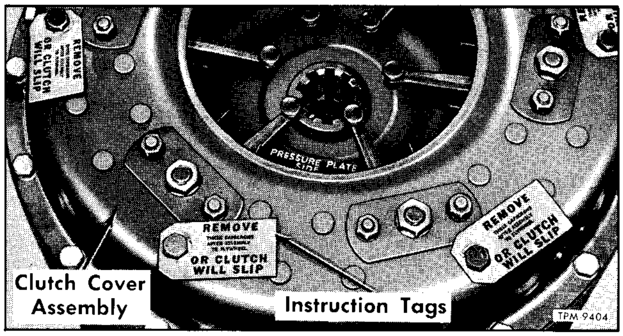


Figure 12—Clutch Cover Bolt Instruction Tags

use straightedge and scale (fig. 13) to check position of release lever buttons (23). With unworn parts, the surface of release lever buttons must be 1-3/8 inches below cover surface. All levers must be in same plane within 0.030 inch. Position of levers can be changed by turning yoke adjusting nuts as required.

NOTE: The yoke adjusting nuts on new cover assemblies are locked in place at time of manufacture and should not require readjustment, unless it is desired to completely wear out facings.

9. Install transmission assembly as instructed in TRANSMISSION (SEC. 17) in this manual.

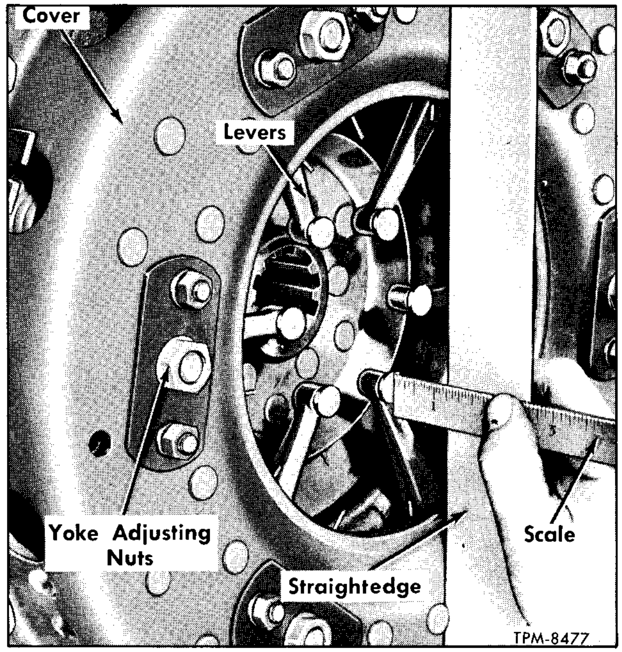


Figure 13—Checking Release Lever Button Position With Scale and Straightedge

10. Adjust clutch controls, referring to "Clutch Linkage Adjustments" covered previously in this section.

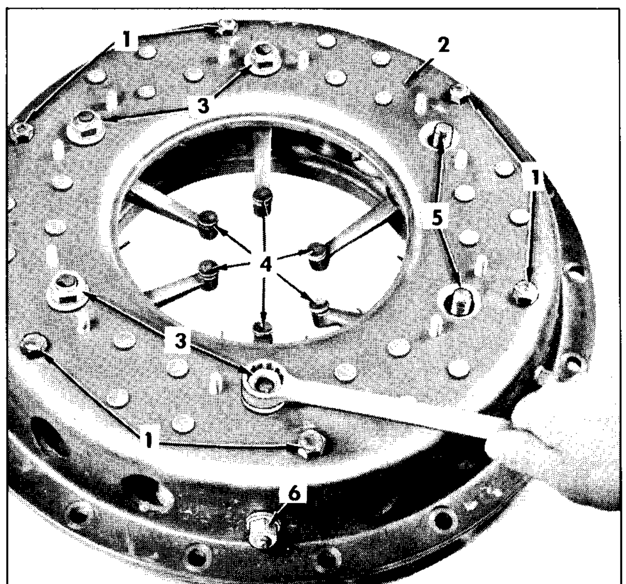
CLUTCH OVERHAUL

Whenever necessary to disassemble clutch cover and pressure plate assembly, follow the procedures as given below to completely overhaul the unit. Procedure for removing the clutch from engine is given previously in this section under "Clutch Removal."

DISASSEMBLY

Key numbers in text refer to figure 2 unless otherwise indicated.

1. Remove nuts, washers, and thrust plate (29) used to lock each adjusting nut (28).
2. Remove adjusting nuts (fig. 14) from yokes. Hold-down bolts (3/8-16 x 2") will hold springs in compressed position while removing adjusting nuts.
3. Mark cover (12) and pressure plate (9) so that correct relative position will be known when reassembling; then remove six bolts (1, fig. 14), turning screws alternately and in gradual stages until spring pressure between cover and plate has been relieved. Lift clutch cover (12) off the pressure plate assembly.
4. Remove springs and insulators (10 and 11) from pressure plate bosses.
5. Remove cotter pins from release lever pins



1 3/8-16 x 2 Bolts	4 Release Levers
2 Clutch Cover	5 Release Lever Yoke
3 Yoke Adjusting Nuts	6 Driving Block Nut

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Figure 14—Yoke Adjusting Nut Removal

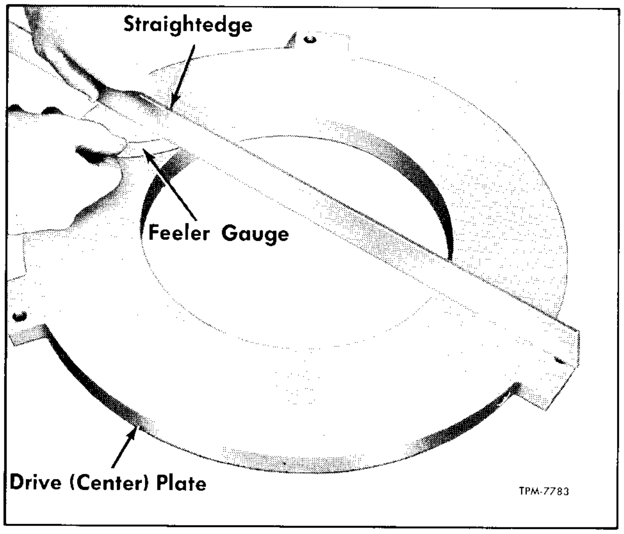


Figure 15—Checking Center Plate for Flatness

and pull out pins. Be careful to note position of washers, springs, and number of rollers (31), so parts can be reassembled correctly.

INSPECTION

Prior to inspection, wash clutch parts (except driven disc facings) in cleaning fluid. Refer to "Specifications" at end of this section for dimensions and clearances.

1. Inspect driven disc assembly for worn, loose or oil-soaked facings; for loose rivets at hub; for distortion. If any of these conditions are evident, new driven disc and facings assembly should be used.

2. To inspect release bearing, first soak in cleaning solvent, tap sharply on wood block to dislodge dirt particles, flush in cleaning solvent and blow dry by directing air at right angle to bearing, revolving slowly by hand. Examine bearing for pits and scores and, if usable, dip in clean oil. Do not disassemble bearings.

3. Inspect pressure plate, center plate, and flywheel plate for checks and scores on contact surface. For refacing of pressure plate, see "Pressure Plate and Flywheel Clutch Plate Repair" under "Repair" later in this section. Check fit of center plate drive lugs in flywheel slots. Dimensions for parts are given in "Specifications" at end of this section. Check surfaces at pressure plate, center plate, and flywheel plate for warpage using straightedge and feeler as shown in figure 15.

4. Check clearance between driving blocks and slotted lugs in pressure plate. If there is indication of wear or scoring on driving blocks, replace same.

5. Clean and inspect rollers used at release lever pins. Replace if rollers show wear.

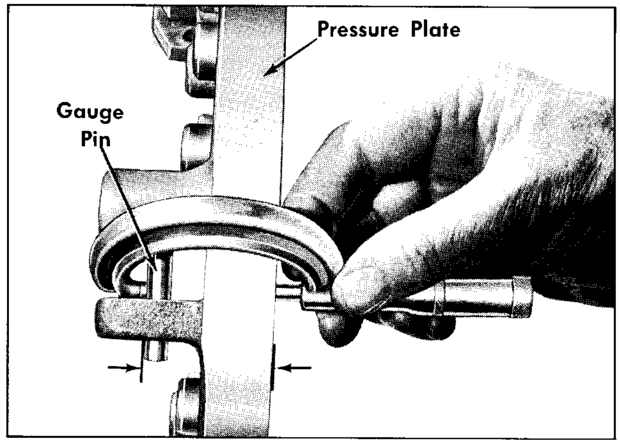


Figure 16—Measuring Pressure Plate Thickness

6. Inspect release levers at needle bearing bores and at thrust buttons. If bearing bores are worn, new levers must be installed at assembly. Thrust buttons can be replaced.

7. Inspect surface on clutch release yoke which contacts buttons in release bearing support. Discard yoke if worn and use new yoke when installing clutch assembly.

8. Test pressure springs (11, fig. 2) and replace any springs which are not within specifications. Springs should be replaced if they appear to have been overheated.

REPAIR

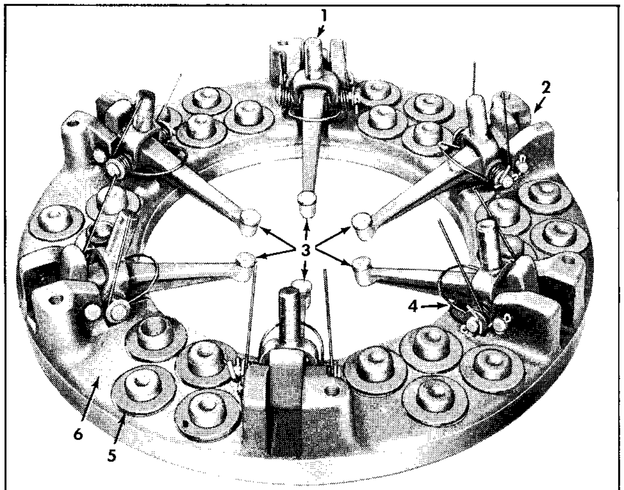
PRESSURE PLATE AND FLYWHEEL CLUTCH PLATE REPAIR

The clutch pressure plate, center plate, or flywheel plate may be refaced by grinding to produce a flat smooth surface. Do not reface parts which are severely heat checked or scored, or if warped in excess of 0.015 inch (fig. 15). If necessary to grind off more than 1/32 inch from pressure plate or flywheel plate to clean up friction surface, new parts should be used at assembly. Before repair of plates is attempted, measure each plate and compare dimensions with new dimensions as listed in "Specifications" at end of this section. Figure 16 shows use of micrometer to check pressure plate thickness. This is necessary to determine if plates have previously been resurfaced.

When resurfacing center plate, no more than 1/64 inch of stock should be removed from each side.

Care must be exercised to maintain friction surfaces parallel with plane of rotation.

To refinish flywheel plate, remove the flywheel assembly from engine and perform machining operation with plate bolted to flywheel. Shim washers 1/32" thick must be used when assembling clutch after resurfacing clutch plates. Therefore,



1 Lever Yoke
2 Drive Slot
3 Release Levers
4 Lever Spring
5 Insulating Washer
6 Pressure Plate

Figure 17—Pressure Plate and Release Levers

when resurfacing these plates, at least 1/32" of stock, total, should be removed at a time. This will permit the use of the 1/32" shims and thereby maintain torque capacity of clutch. Total thickness of stock removed from plates should not exceed 3/32".

No more than three 1/32-inch shims should be used under each pressure spring when building up clutch cover and pressure plate assembly.

CLUTCH RELEASE LEVERS

If thrust buttons (23, fig. 2) are worn, press out the worn buttons and install new ones.

CLUTCH RELEASE BEARING AND SUPPORT ASSEMBLY

If inspection indicates worn or damaged bearing, use arbor press to press old bearing off support and install new bearing assembly. Bearing inner race must seat solidly against shoulder on support. If thrust buttons (18, fig. 2) are worn, remove worn buttons and install new ones.

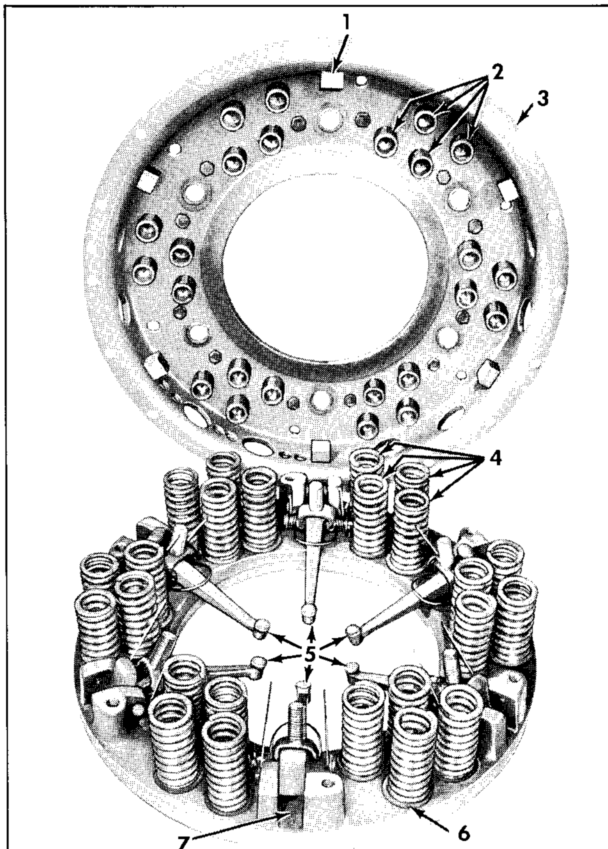
CLUTCH ASSEMBLY

Key numbers in text refer to figure 2 unless otherwise indicated.

1. Assemble adjusting yokes (30) and springs (27) on clutch release levers as follows:

a. Make two pilot pins slightly shorter than needle rollers (approx. 5/8") and same diameter as pins (33 and 36). Chamfer ends of pilot pins.

b. Lay lever (32) on flat surface and insert a pilot pin in each hole. Arrange full compliment of rollers (31) around each pilot pin. Do not lubricate bearing rollers. Place yoke (30) and spring (27) over lever in position shown in figure 17. Place



1 Drive Block
2 Spring Guides
3 Cover Assembly
4 Pressure Springs
5 Release Levers
6 Spring Insulator
7 Drive Block Slots

Figure 18—Springs and Levers in Position For Installing Cover Assembly

flat washer on yoke pin (36), then insert pin through spring, yoke and lever, thereby pushing out pilot pin. Assemble flat washer and cotter pin to retain pin (36).

c. Position lever and yoke assembly at pressure plate (9), then install lever pin (33) and retain with cotter pin.

d. Repeat procedure described in steps b. and c. above to assemble each lever to pressure plate. Refer to figure 17 for view of release levers installed on pressure plate.

2. Place pressure plate and levers assembly (fig. 17) face downward on bench. If the pressure plate, center plate, or flywheel plate have been resurfaced, place 1/32" shims between insulating washers (28) and spring bosses on pressure plate. Use one shim for each 1/32" of material removed during resurfacing operations. Refer to figure 18 for proper position of springs on pressure plate.

3. When insulating washers (10) and springs (11) are in position, set cover (12) over springs

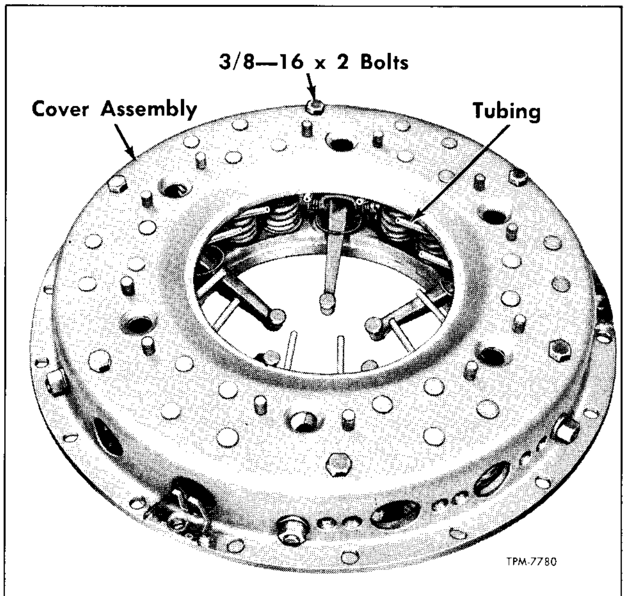


Figure 19—Installing Cover Plate on Pressure Plate

(11), fitting each spring guide on cover into corresponding spring. Cover must assume original position in relation to pressure plate. Refer to alignment marks made at disassembly to determine correct position. Drive blocks (34) must enter slots in pressure plate.

4. See that ends of springs (27) do not catch under cover. Pieces of tubing 1/4 inch by 4-1/2 inches long may be placed on spring ends shown in figure 19, to guide ends of springs past cover.

5. Install six bolts (3/8" - 16 x 2", fig. 19) through holes in cover plate, starting each bolt into tapped hole in pressure plate, then tighten alternately and in gradual stages to compress springs (11) and bring threaded ends of yokes (30) into respective holes in cover plate. Guide yokes through holes as bolts are tightened.

6. Thread adjusting nuts (28) onto yokes (30) so that end of yoke is approximately flush with top of nut. Refer to figure 14.

7. Install adjusting nut thrust plates (29), but do not tighten plate retaining nuts until release lever height has been adjusted.

ADJUSTING RELEASE LEVER HEIGHT

Release levers may be adjusted by using spacers and a spare flywheel assembly as directed in following steps:

1. Place one spacer, 0.440 inch thick, in flywheel to which is assembled a new flywheel plate (6, fig. 2).

2. Lay center plate (8, fig. 2) on spacer, then place another spacer of same thickness (0.440") on center plate.

3. Install cover and pressure plate assembly to flywheel and tighten cover bolts.

4. Remove six hold-down bolts, then turn yoke adjusting nuts (fig. 14) to bring each lever height to 3.635 inches measured from friction surface on flywheel plate to crown of lever thrust button.

5. Tighten twelve nuts to secure thrust plates (29, fig. 2). Proper torque for thrust plate nuts is 20 foot-pounds. Use staking tool at threads to lock the adjustment.

6. After setting lever height, install six 3/8-16 x 2 inch bolts through holes in cover and into tapped holes in pressure plate to keep plate retracted until installed on engine.

7. Remove cover and pressure plate assembly from spare flywheel.

SPECIFICATIONS

Clutch Mfr.	Long Mfg. Div.
Mfr. No.	C-50-B-163
Type	Direct-Pressure with Two Driven Discs
Size	15-inch
Clutch Driven Discs:	
Number Used	2
Front Driven Disc No. (Stamped)	C-46-413
Rear Driven Disc No. (Stamped)	C-46-414
Thickness (each disc)	0.4350″-0.4450″
Clutch Pressure Plate:	
Release Lever Pin Hole I.D.	0.3285″-0.3305″
Drive Slot Width	0.7600″-0.7630″
Friction Surface Flat Within	0.005″
New Pressure Plate Thickness (Friction Surface to Pin—Fig. 16)	1.739″-1.750″
Drive (Center) Plate:	
Original Thickness	0.898″-0.892″
Friction Surfaces Flat Within	0.005″
Flywheel Plate:	
Original Thickness	0.745″-0.755″
Friction Surface Flat Within	0.005″
Clutch Pressure Springs:	
Number Used	24
Free Length (Approx.)	2.843″
Lbs. Pressure @ 2″	120-125
Clutch Release Bearing	Ball Type
Clutch Pilot Bearing	Ball Type
Clearance Between:	
Drive Blocks and Pressure Plate	0.008″-0.015″
Drive (Center) Plate Lugs and Flywheel Slots	0.007″-0.012″
Clutch Adjustment:	
Release Levers to Face of Cover (With New Facings)	1⅜″
Release Levers to Flywheel Plate	3.635″
CLUTCH RELEASE LINKAGE	
Type	Manual with Air Assistance
Air Cylinder:	
Make	Midland Ross
Type	Single Action Piston
Size (Diameter)	2½″
Air Control Valve:	
Make	Bendix-Westinghouse
Type	Pull-in Linkage
Pull Required to Open Inlet Valve	40 lbs.

Cooling System

DESCRIPTION

Engine is cooled by liquid which is circulated within a sealed system. Cooling system units include: water pump, radiator, surge tank and engine thermostats. A fluid-driven fan mounted on housing at front of engine (fig. 1) forces air through radiator core for cooling. Some radiators are equipped with shutters which aid in controlling temperature.

On coaches with hydraulic transmission, cooling system liquid is used to carry heat away from heat-exchanger on transmission. Pressure valve at surge tank is used to maintain pressure within cooling system. Temperature of coolant within engine is controlled by engine thermostats in thermostat housing at front of engine. Cooling system is filled through filler cap at surge tank (fig. 2).

Water for heating coach is supplied from the engine cooling system.

An alarm buzzer and tell-tale warning light at instrument panel warns the driver in case engine becomes overheated. In addition some vehicles have a temperature gauge at instrument panel which is operated from electrical sending unit installed on engine.

A water filter is installed as special equipment on some coaches to prevent corrosion and accumulation of sediment in cooling system.

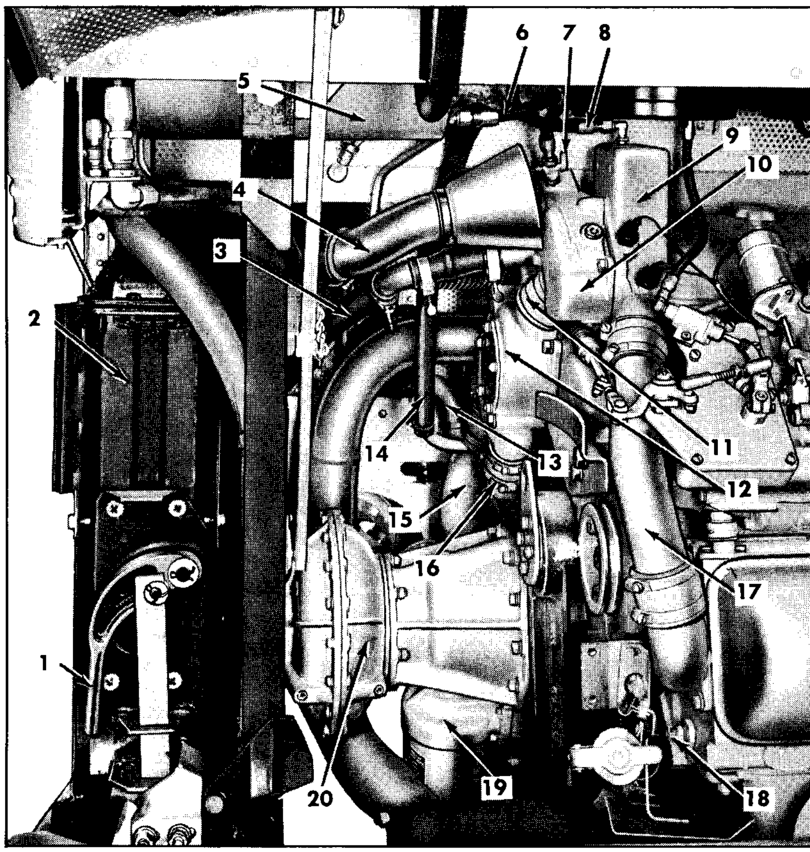
CIRCULATION

Coolant circulation during warm up differs from circulation after engine has reached normal operating temperature as explained in following paragraphs.

ENGINE WARM-UP

The two temperature control thermostats are located in a housing at front of engine. Water pump pumps coolant into cylinder block, by way of engine oil cooler. After circulating through block and cylinder heads coolant enters thermostat housing. When engine is cold (below 165°) the thermostats are closed and prevent coolant from flowing to radiator, so the coolant returns to water pump

6



1 Radiator Latch Handle
2 Radiator Assembly
3 Heater Feed Line
4 Water Line to Radiator
5 Surge Tank Assembly
6 Vent Line
7 Vent Cock
8 Deaeration Line
9 Thermostat Housing
10 Thermostat Housing Cover
11 Water By-Pass Hose
12 Water Pump Assembly
13 Heater Return Line
14 Pump Return Line
15 Radiator to Pump Line
16 Pump to Cooler Line
17 Cylinder Head to Thermostat Housing Line
18 Drain Cock
19 Oil Filter
20 Fluid Fan Drive Torus Housing

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Figure 1—Cooling System Units—8 Cylinder Shown

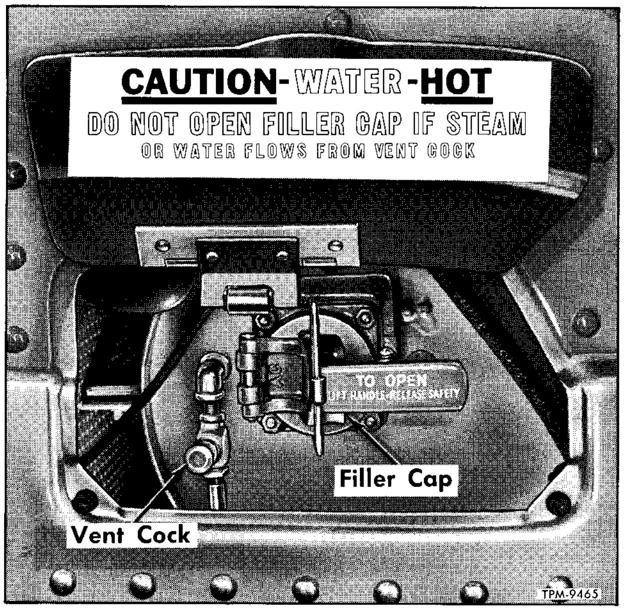


Figure 2—Surge Tank Filler and Vent Cock

through by-pass openings in housing. During warm-up, coolant also circulates through air compressor cylinder head, through heat-exchanger at transmission (TDH Models), through heater lines in coach body, and through surge tank.

AFTER WARM-UP

When coolant reaches temperature at which engine thermostats open, coolant begins to flow through radiator. Heat at this time is sufficient to actuate fan control valve and cause the fan to operate. Coolant continues to circulate through air compressor, heat exchanger at transmission (TDH Models), coach heating system, and surge tank. Refer to DIESEL ENGINE MANUAL for operation and maintenance of Fluid Fan and Controls.

DRAINING COOLING SYSTEM

Drain cocks are provided at engine, radiator, and in heating system. A shut-off valve in heater line can be closed to permit draining engine without draining heater lines. Press and hold relief valve (vent cock) at surge tank to relieve pressure, then block filler cap open to vent cooling system while draining. Open drain cocks and remove plugs at points indicated below.

ENGINE COOLING SYSTEM DRAIN POINTS

1. Remove drain plug from radiator outlet connection at bottom of radiator (B, fig. 3).
2. At bulkhead side of engine open drain cock at oil cooler (E, fig. 3).
3. Remove pipe plug at air compressor (C, fig. 3).
4. At rear side of engine, open drain cock at front of cylinder head (A, fig. 3), also at rear of cylinder block (D, fig. 3).
5. When used as special equipment, remove plug from bottom of filter housing (F, fig. 3).
6. Refer to "HEATING AND VENTILATION" in BODY (SEC. 3) for instructions covering draining of heater lines.

FILLING COOLING SYSTEM

Only pure, soft water and ethylene glycol type antifreeze should be used in cooling system. Additional information concerning use of antifreeze is given later in this section.

CAUTION: On coaches equipped with water filters, follow the procedure given later when servicing the water filter.

FILLING EMPTY SYSTEM

1. Close all drain cocks and install drain plugs, referring to draining procedure for location of drain points.
2. Open shut-off cock in vent line at top of thermostat housing at front of engine (fig. 1).
3. If heater line shut-off valve has been closed, open valve.
4. Through filler cap (fig. 2) slowly fill system to level of filler cap opening.
5. Refer to "HEATING AND VENTILATION" in BODY (SEC. 3) for instructions on bleeding heating units when filling a completely empty system.
6. After all lines have been bled, close vent line shut-off cock at fitting in top of thermostat housing (fig. 1).

REPLENISHING COOLING SYSTEM

1. Press relief valve button (vent cock) on surge tank, and hold in depressed position until all pressure is relieved from system.

CAUTION: If engine is overheated, wait until boiling stops and engine has cooled before adding cold water. Then with engine running, add water slowly as directed in step 2 below.

2. At surge tank (fig. 2) open filler cap, and add water to level of cap opening.
3. If water in cooling system was very low bleed heating system units to make sure all air is expelled. Refer to "HEATING AND VENTILATION" in BODY (SEC. 3) of this manual.

COOLING SYSTEM INSPECTION AND MAINTENANCE

PERIODIC INSPECTION

At regular intervals, cooling system units should be inspected to determine if service is required. Regular systematic checks will indicate

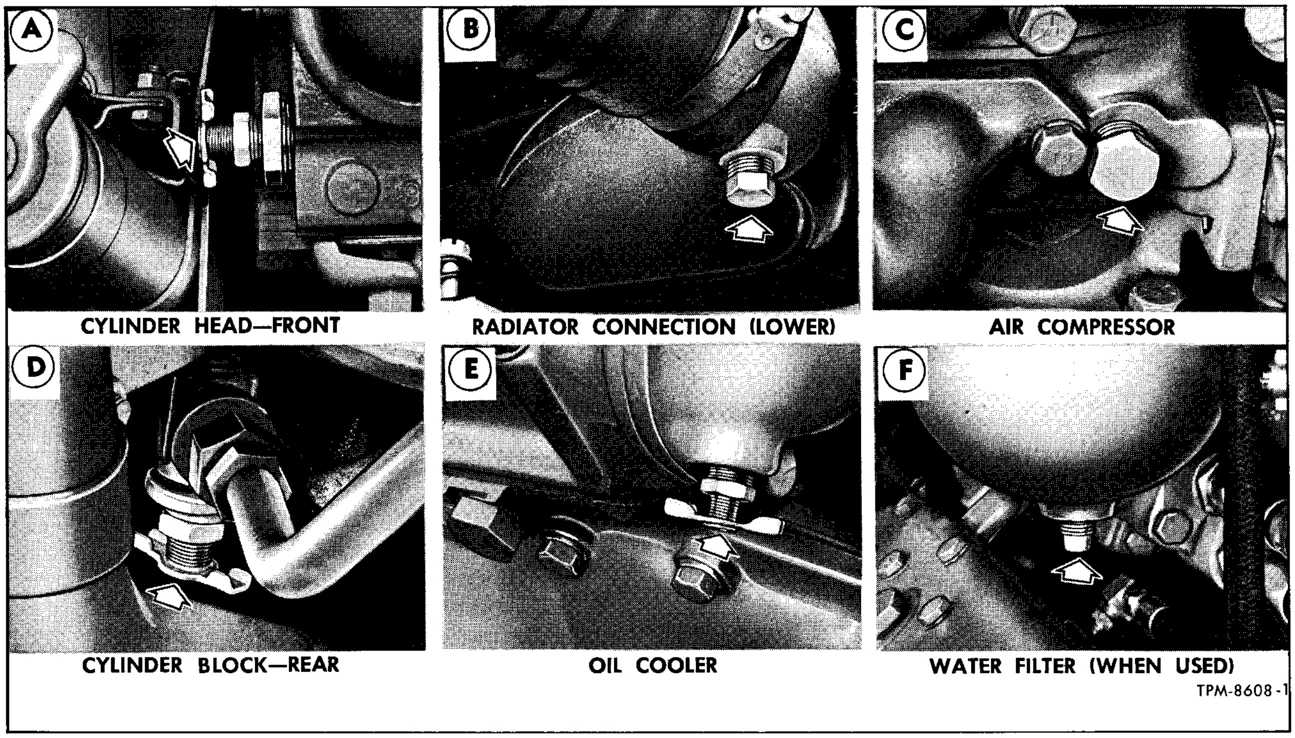


Figure 3—Location of Cooling System Drain Points

condition of various units and indicate necessity of servicing or replacement of units which can be made before failures occur.

1. At surge tank, check coolant level by pressing relief valve button (vent cock). If liquid flows out, system contains adequate solution. If coolant is low add water as necessary. NOTE: Refer to previous instructions for filling cooling system.
2. Check hose connections and tighten clamps as necessary. Cracked, swollen, or deteriorated hoses must be replaced.
3. Check radiator core and heater cores for leaks and for accumulation of dirt which obstructs air passage. Clean cores with air hose using low pressure. Repair all cooling system leaks at first opportunity. Refer to DIESEL ENGINE MANUAL for procedure to remove and overhaul water pump.
4. Inspect the radiator mountings and tighten mounting bolts when necessary.
5. If radiator is equipped with shutters, check operation of shutter air cylinder, and service the air filter assembly as directed in "Radiator Shutters" later in this section.
5. Check operation of fluid fan (fig. 1) which must not run at full speed when engine is cold, but must operate when engine has reached normal operating temperature.
6. Inspect for clearance between fan blades and radiator core and fan shroud. Correct as necessary.

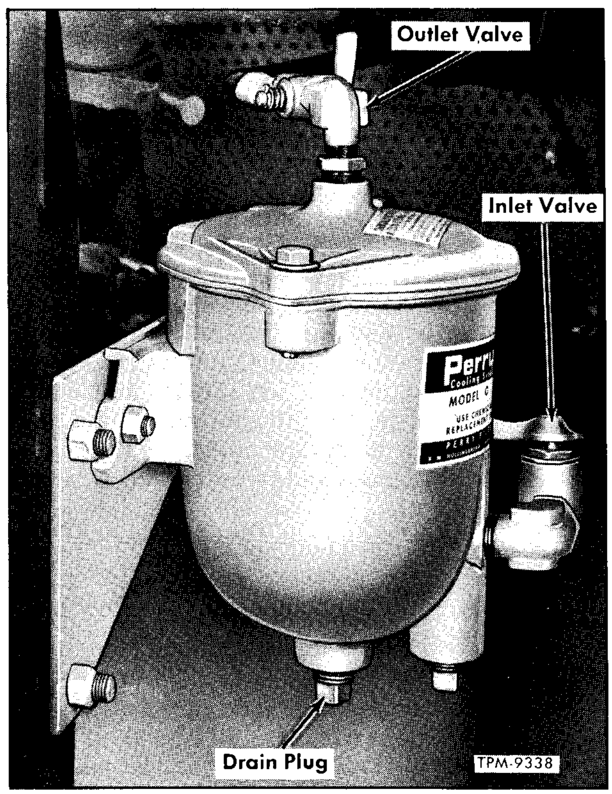
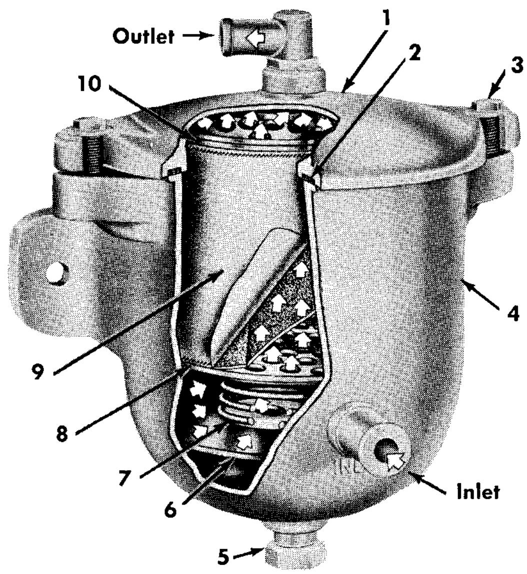


Figure 4—Water Filter Installed—6 Cylinder Shown



1 Cover	6 Sump Plate
2 Gasket	7 Spring
3 Bolt	8 Lower Plate
4 Body	9 Element
5 Drain Plug	10 Upper Plate

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Figure 5—Sectional View of Water Filter

7. Inspect air recirculation seals at baffles around radiator assembly. Seals must be in good condition.

8. Inspect and service water filter (if used) as directed in this section.

WATER FILTER

Water filter (fig. 4) as installed on some vehicles is used to filter and condition water in cooling system. On a new engine, the filter element should be initially changed after 2500 to 3000 miles. After initial change, the filter should be serviced periodically 7,500 to 10,000 miles or 300 to 500 hours depending upon engine workload, conditions, etc.

Except when anti-freeze is used, color of water in system should be a golden yellow. No rust preventive or inhibitor should be used in system when water filter is used.

IMPORTANT: Some permanent-type anti-freeze solutions may contain inhibitor which will produce a green residue or precipitation. If this is noted more frequent element change periods will be necessary and if this fails to correct condition, the filter element should be removed, or the filter disconnected.

ELEMENT REPLACEMENT

NOTE: Key numbers in text refer to figure 5.

1. For convenience in changing element, close off filter supply and return hose by closing two cocks.

2. Remove two bolts (3) which attach cover (1) to filter. Remove cover and cover gasket (2).

3. Remove drain plug (5) from bottom of filter.

4. Remove upper plate (10), element (9), lower plate (8), spring (7), and sump plate (6) from filter body (4). Flush out filter body.

5. Discard filter element, then clean all parts. Examine element lower plate for excessive corrosion.

NOTE: Deep pits in the plate do not warrant replacement. Clean plate by wire brushing. This plate generates current for the electrochemical action of filter element. If excessively corroded, replace.

6. Referring to illustration, position sump plate (6), spring (7), lower plate (8), new element (9), and upper plate (10) in filter body (4). Install cover (1) using new gasket (2). Tighten cover attaching bolts evenly and firmly.

7. Remove vise grips from filter hoses. Start and operate engine until water in cooling system is warm. Check for air lock in filter. If cover of filter becomes warm no air-lock condition exists in system. If cover remains cool, vent system same as for a hot water heater system.

8. Refill system to proper level.

9. IMPORTANT: Make sure that filter body is grounded back to engine, otherwise electro-chemical action of filter element will be affected.

ENGINE TEMPERATURE CONTROL

ENGINE THERMOSTATS

Engine thermostats are located in outlet housing at front of engine (fig. 1).

When engine is cold, the thermostats are closed and prevent water from circulating through radiator; instead, the coolant passes through a bypass to water pump where it is recirculated through engine oil cooler, cylinder block and cylinder heads.

Proceed as follows to replace thermostats.

1. Remove muffler, which is accessible with engine compartment rear door open.

2. Close shut-off valve in heater line and open drain cocks at each end of cylinder block to drain water level below thermostat housing. Plug at bot-

tom of radiator may be removed to drain out water more rapidly.

3. Remove heat shield and loosen hose clamps on by-pass hose and the hose connecting housing to pipe.

4. Remove bolts which attach cover to housing, then remove cover and two thermostats (fig. 6).

5. Place thermostats in position in cover with element toward engine. Install cover using new gasket. Fit the thermostat cover into by-pass and radiator pipe hoses before installing cover bolts.

6. After installing cover bolts, position hose and tighten clamps. Fill cooling system, start engine and inspect hose connections for leaks. Install heat shield at upper hose near muffler as shown in figure 1.

7. Install muffler.

TEMPERATURE GAUGE AND SENDING UNIT (SOME COACHES)

Some coaches have an electrically operated temperature gauge in instrument panel which registers engine temperature. Sending unit is installed in engine thermostat housing. Circuit does not operate when "MASTER" control switch is in "OFF" position.

Refer to "Alarm and Signal Wiring Diagram" for electrical wiring circuits when tracing wiring between sending unit and gauge. When used, the sending unit is installed in tapped boss adjacent to engine overheat switch. DO NOT USE THREAD COMPOUND ON SENDING UNIT THREADS when installing.

WATER TEMPERATURE (OVERHEAT) SWITCH

A tell-tale light at instrument panel and alarm buzzer are used to warn driver of overheated engine. Overheat switch is installed in engine thermostat housing and is connected to wiring harness. Switch is a sealed unit and is not adjustable.

OPERATION

Engine overheat switch has internal contact points which are normally open at temperature below 210°F. In case engine temperature rises to 210°F. to 214°F., the contact points will close and complete the electrical circuit which causes tell-tale light and buzzer to operate.

OVERHEAT SWITCH REPLACEMENT

1. Disconnect wire from terminal on switch, then use wrench to screw switch body out of thermostat housing.

2. Screw switch into housing and tighten firmly. DO NOT USE COMPOUND ON SWITCH BODY THREADS. Threads are dry-seal type. Use of compound may prevent proper transfer of heat and hinder flow of electric current.

3. Connect wire to terminal.

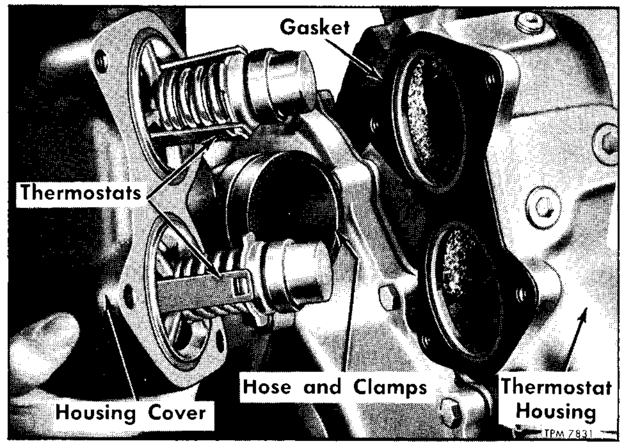


Figure 6—Engine Thermostat Replacement

FLUID DRIVE FAN

Fan for cooling radiator is installed at front end of engine as shown in figure 1.

The fan is driven by torus members located in fan drive torus housing. Oil from engine crankcase is used to fill torus housing to operate fan. Construction, operation, and repair of fluid fan and control valve are covered in GM DIESEL ENGINE MANUAL. The fluid fan control valve is thermostatically actuated by temperature of water in pipe between water pump and oil cooler. The fan blade assembly is bolted to flange on drive hub.

RADIATOR AND SURGE TANK

Radiator is located at left rear corner of coach and is covered by a grille door. Radiator on 6-cylinder is stationary, while 8-cylinder is hinged.

MOUNTING - 6-CYLINDER

Radiator is mounted on support member attached to bracket on engine compartment bulkhead and to engine cradle member. Top of radiator is held in position by a bolt and rubber spacers. Radiator is supported at two bottom corners on fabric washers, which provides a semi-rigid mounting.

MOUNTING - 8-CYLINDER

Radiator is mounted to body by two rubber insulated hinges (fig. 7) which permits radiator to swing outward, thereby providing accessibility to fan blades, hoses, and so forth at front of engine. A latch and handle (fig. 8) is used which permits radiator assembly to be locked in place or released when it is to be hinged outward.

COOLING SYSTEM

SURGE TANK

Surge tank installed above radiator is equipped with pressure valve assembly. Pressure valve incorporates two valves; one of which relieves excessive pressure and another which admits atmosphere as coolant contracts after engine is stopped. An overflow tube is connected to pressure valve.

RADIATOR INSPECTION

At regular intervals, check core attaching bolts for tightness. Check lower mounting for worn or deteriorated insulators, and loose or missing nuts. Check condition of support upper rubber mountings.

At regular intervals, or when operating conditions warrant, examine radiator core for leaks and bent fins. A damaged or clogged radiator should be serviced by a radiator specialist or replaced with a new one. Efficient repair of radiators requires the use of special tools and equipment as well as provisions for making proper tests. If radiator core requires painting, spray with special radiator paint; do not use paint mixed with oil, as oil mixed paint will form an insulation and prevent efficient dissipation of heat.

Check for clearance between fan blades and radiator shroud. Distance between blades and shroud should be equal all around. Whenever adjustment is necessary shroud attaching bolts can be loosened and shroud adjusted to provide proper clearance.

Radiator on 8-cylinder equipped vehicles is adjustable at latch bracket (fig. 9). so that radiator may be moved inward or outward as necessary to obtain proper fit between grille door and radiator. Radiator latch strike plate is also adjustable to obtain tight fit of latch plunger in latch bracket slot.

COLD WEATHER OPERATION

In cold regions, antifreeze must be used in cooling system to prevent damage by freezing. Before installing antifreeze solution, cooling system should be inspected and serviced as previously described in this section.

Tighten cylinder head bolts and, if necessary, replace gasket, to prevent leakage of antifreeze into engine and exhaust gases into cooling system.

THAWING COOLING SYSTEM

If coolant freezes solid, place coach in a warm building until ice is completely thawed.

CAUTION: UNDER NO CIRCUMSTANCES SHOULD ENGINE BE RUN WHEN COOLING SYSTEM IS FROZEN SOLID.

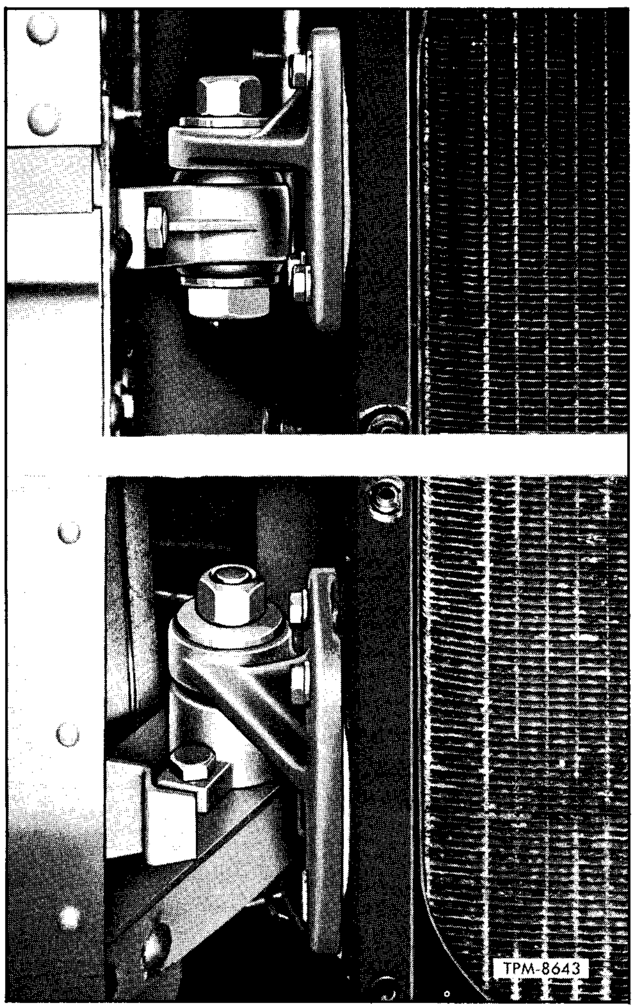


Figure 7—Radiator Hinges—8 Cylinder

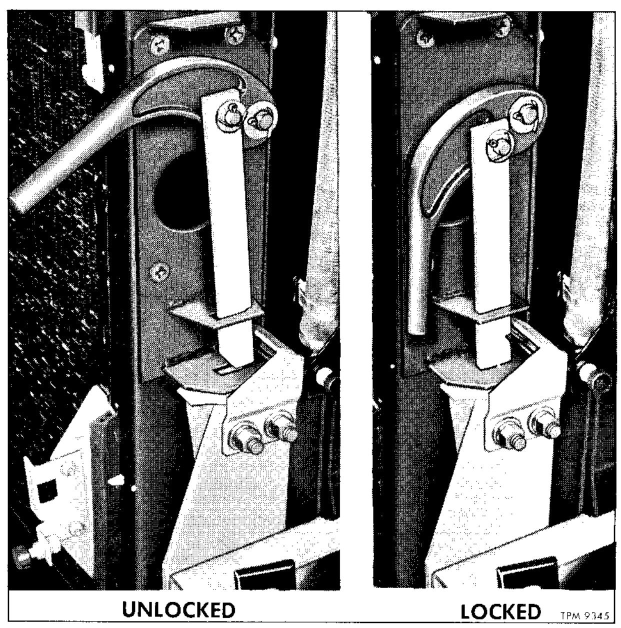


Figure 8—Radiator Latch and Handle —8 Cylinder

ANTIFREEZE SOLUTIONS

Only ethylene-glycol type antifreeze solution is recommended for use in these vehicles. Ethylene glycol solutions have the advantage of a higher boiling point and may be used at higher temperature without loss, resulting in more efficient performance of cooling system. Ethylene-glycol has the further advantage that, in a tight system, only water is required to replace evaporation losses. However, losses through leakage or foaming must be replaced by additional new solution. Under ordinary conditions, ethylene glycol solutions are not injurious to body finish.

Testing Antifreeze Solution

Always test solution before adding water or antifreeze. Engine should be warmed up to operating temperature. Fill and empty tester several times to warm tester before using. Keep tester clean inside and out.

Some testers will indicate correct freezing point only when test is made at a specific temperature. Other testers are provided with thermometers and tables and indicate freezing points corresponding to readings made at various temperatures. Disregarding temperatures of solution may cause an error as large as 30°F. Read and be guided by instructions furnished by tester manufacturer.

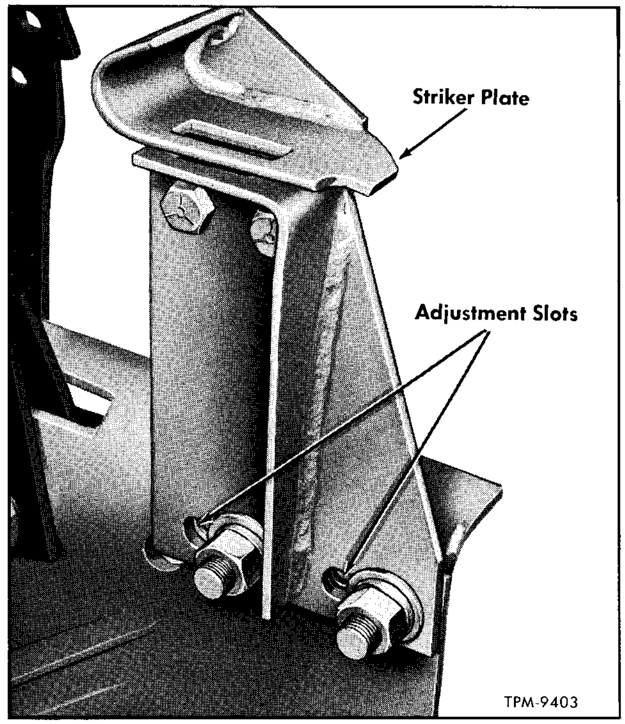


Figure 9—Radiator Latch Adjustable Bracket—8 Cylinder

SPECIFICATIONS

COOLING SYSTEM CAPACITIES

Quarts of Coolant Required—6 Cylinder Engine *77
Quarts of Coolant Required—8 Cylinder Engine *96

*Capacity is Approximate and Includes Heating System.

ANTI-FREEZE CHART

LOWEST EXPECTED TEMP. (F°)	QTS. OF ETHYLENE GLYCOL REQUIRED 6 CYL.	8 CYL.
+10	19¼	24
0	25	31
−10	28½	35½
−20	32	41¾
−30	36½	45¾

THERMOSTAT—WATER CIRCULATION

Number Used 2
Start to Open .... 165°
Fully Open .... 180°

OVERHEAT SWITCH (ALARMSTAT)

Make .... AC
Vendor No. 1513806
Points Set to Close at .... 212 °F. ± 2°

SURGE TANK PRESSURE VALVE

Valve Opens at (Pressure in Lbs. per Sq. In.) .... 6½ to 7¾

FAN

Drive .... Fluid Coupling—from Crankshaft
Drive Control .... Thermostatically-Operated Valve
Number of Fan Blades 6
Diameter .... 26″
Direction of Rotation .... Counterclockwise

TEMPERATURE GAUGE (When Used)

Make .... AC
Type .... Electrical
Operating Range .... 120°-280°
Voltage 12V

Electrical System

This group, covering complete maintenance and repair information on Electrical Systems, is divided into six sections as shown in index below.

NOTE: Specifications are listed at end of each section.

INDEX OF ELECTRICAL UNITS

Certain electrical units, when closely associated with some other system or unit, are covered in other sections of this manual. The index following lists all major electrical units, together with the manual section in which they are covered and page number on which the section begins.

*Refer to "Hydraulic Drive - Model VH" Operation and Maintenance Manual.

Wiring and Miscellaneous Electrical

The electrical system is divided into several separate systems, each system being classified according to its function or purpose. A separate wiring diagram is provided for each major system. In some cases, a circuit on one diagram ties-in with circuits shown on other diagrams, and cross-references are made to other diagrams. Wiring diagrams are folded and bound in back of this manual in MD number sequence for easy reference. These diagrams include all standard diagrams,

and diagrams covering the most commonly used special equipment such as air conditioning and automatic engine shut-off systems. Due to the many various combinations and types of special equipment used by different operators, it is impractical to include all special equipment wiring diagrams in this manual. Each operator can obtain wiring diagrams covering his particular special equipment upon request from the factory. Following is a list of wiring diagrams included in this manual, with a brief outline of the units shown on each diagram.

ELECTRICAL CIRCUIT DIAGRAMS

Engine Control and Generator Wiring Diagrams - MD-91451, MD-91275, MD-91453, and MD-91515

Four engine control and generator wiring diagrams are included - MD-91451 covers standard TDH and SDH models; MD-91275 covers standard TDM and SDM models; MD-91453 includes automatic engine shut-off system on TDH and SDH models; and MD-91515 includes automatic engine shut-off system on TDM and SDM models.

These diagrams show the generator, regulator, batteries, starter, solenoids, relays, and switches necessary to start and stop the engine. Also included on the special equipment diagrams is the engine stop time delay relay which is connected into the low oil pressure and hot engine alarm circuits. Schematic diagrams of the "MASTER" control switch are also shown on each of these diagrams.

Alarm and Signal Circuit Diagram - MD-86080

This diagram shows all switches, relay, buzzer and rectifier assembly, tell-tale lights, gauges, sending units, circuit breakers, and wiring circuits necessary for the operation and control of all audible and visual alarm and signal devices except stop and directional lights, which are shown on a separate diagram.

Hydraulic Transmission Wiring Diagram - MD-87492

This diagram shows the hydraulic transmission control relay, direct drive solenoid, governor switch, transmission shift lever switch, and interconnecting circuits necessary for the automatic operation of the hydraulic drive transmission on TDH and SDH models.

Mechanical Transmission Wiring Diagram - MD-86076

This diagram shows the transmission reverse solenoid, reverse relay, reverse switch, and interconnecting circuits for TDM and SDM models. It also includes transmission low oil tell-tale and switch.

Lighting System Wiring Diagram - MD-85623 (TDH & TDM); MD-86366 (SDH & SDM)

These diagrams show all interior and exterior lights and their controlling switches, relays, and circuit breakers except tell-tale lights, and stop and directional signal lights, which are shown on other diagrams.

Heating and Ventilation Wiring Diagram - MD-86077

This diagram shows heating and defroster blower motors and water pump motor, together with their controlling switches, circuit breakers, and relays on coaches equipped with standard heating system without air conditioning; schematic views of defroster switch operation are also included.

Air Conditioning Wiring Diagram - MD-86084

This diagram shows the defroster, water pump, and blower motors and controls, together with the solenoids, switches, and relays required for the operation of the air conditioning system; schematic views of air conditioning switch operation are also included.

Door Control Wiring Diagram - MD-86083

This diagram shows the air-electric door control valve, relays, exit door solenoid, brake interlock magnet valve, and interconnecting circuits on coaches equipped with standard door controls only. Special equipment door control diagrams are not included in this manual. Each operator can obtain door control wiring diagrams for his specific equipment upon request from the factory.

Stop and Directional Light Wiring Diagrams - MD-86081, MD-86583, and MD-89656

MD-86081 shows standard front directional lights, combination rear stop and directional lights, and controlling switches, relay, and interconnecting circuits. Special side directional lights are also shown. MD-86583 shows stop and directional lights with special equipment foot-operated directional light switches. MD-89656 shows stop and directional lights with special equipment emergency flashing system.

Speedometer Wiring Diagram - MD-86078

This diagram shows speedometer drive unit, circuit breaker, fuse, and circuits required to operate the electric speedometer.

Master Wiring Diagram

This is a simplified schematic wiring diagram showing all standard electrical circuits on one composite diagram.

WIRE SIZES AND COLORS

Each wire in the electrical system is of a specific size as designated on the Wiring Diagrams. When replacing wires, the correct size as indicated must be used. Never replace a wire with one of a smaller size.

The insulation on each wire is distinctly colored and patterned to assist in tracing and testing circuits, and to assist in making connections.

Abbreviations and symbols are used in wire insulation color and pattern designations on Wiring Diagrams and in the tabulations which follow. Abbreviations and symbols are as follows:

*Blk.	Black	Nat.	Natural
Brn.	Brown	Or.	Orange
Ch.	Check	Tr.	Tracer
Cr.	Cross	Yell.	Yellow
Grn.	Green	//	Parallel

*All wires leading from the engine compartment apparatus box junctions and circuit breakers into the engine compartment are covered with black heat-resistant insulation. To assist in making proper connections, a tag near end of each wire bears the number or abbreviation of the terminal to which it connects.

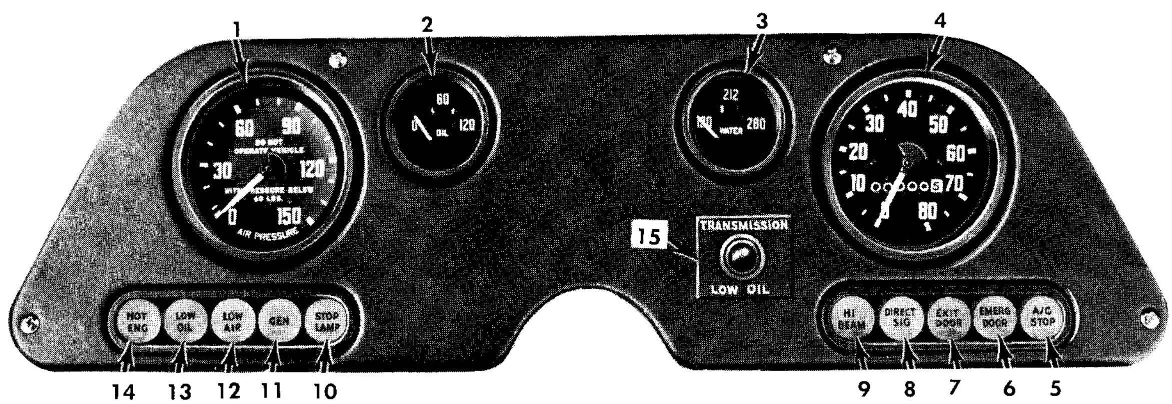
TESTING CIRCUITS

A careful study of the wiring diagrams should be made to determine the source and flow of current through each electrical circuit. When a circuit is thoroughly understood, a point to point check can be made with the aid of the applicable wiring diagram, to determine the location of the trouble. Any circuit can be tested for continuity or short circuits with a 2-candlepower test light or low-reading voltmeter.

All electrical connections must be kept clean and tight. Loose or corroded connections will cause discharged battery, difficult starting, dim lights, and improper functioning of other electrical circuits. Inspect all wiring connections at regular intervals. Make sure knurled nuts on all amphenol plugs are securely tightened. Refer to other sections previously listed under "Index of Electrical Units" for information on major electrical units and systems.

CAUTION: Voltage on output side of fluorescent lighting power supply unit is dangerous. When any malfunction in the fluorescent lighting system is indicated, observe precautions and trouble-shooting procedures outlined in "LIGHTING SYSTEM" section in this manual.

GAUGE AND TELL-TALE PANEL



1 Air Pressure Gauge
2 Oil Pressure Gauge *
3 Water Temperature Gauge *
4 Speedometer
5 Air Conditioning Stop Tell-tale *
6 Emergency Door Tell-tale
7 Exit Door Tell-tale
8 Directional Signal Tell-tale
9 Hi-Beam Tell-tale
10 Stop Light Tell-tale
11 Generator No-Charge Tell-tale
12 Low Air Pressure Tell-tale
13 Low Oil Pressure Tell-tale
14 Hot Engine Tell-tale
15 Transmission Low Oil Tell-tale (TDM & SDM Models)

*Special Equipment.

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Figure 1—Gauge and Tell-Tale Panel

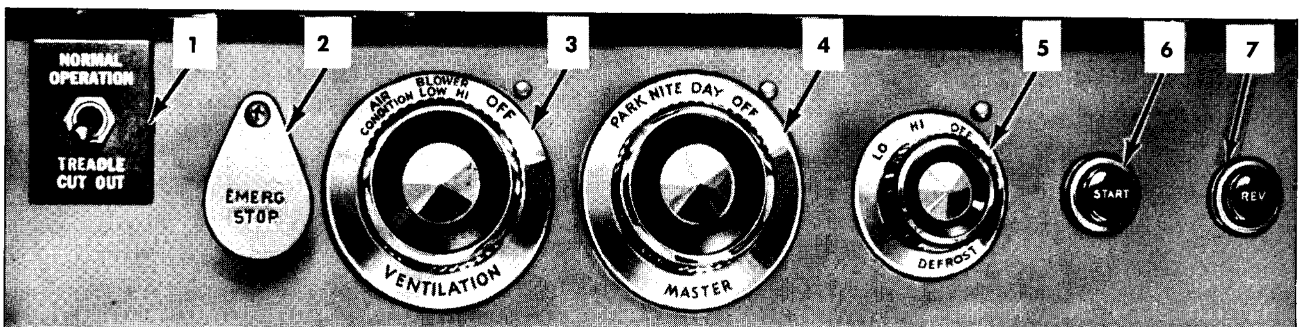
Gauge and tell-tale panel (fig. 1) is mounted directly in front of driver. Gauge and speedometer faces are illuminated by lights installed in gauge cases. Five tell-tale lights are used in each tell-tale panel. Names on tell-tale windows are visible only when tell-tale lights are illuminated. Tell-tale and instrument bulbs are mounted in snap-in type sockets. Operation of tell-tale lights is described later under "Tell-tale Alarm System." Gauges and tell-tale light holders are secured in instrument panel by studs, nuts, and mounting clamps.

DRIVER'S CONTROL PANEL

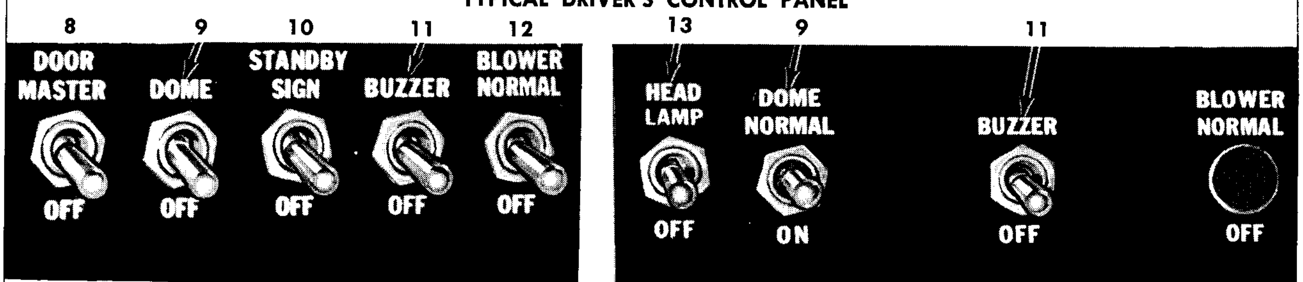
All switches used by the driver for normal operation of the vehicle are located on the control panel at left of driver and on a recessed switch panel directly below the control panel.

Control panel shown in figure 2 is for a coach equipped with air conditioning and a mechanical transmission. The "VENTILATION" switch is omitted on coaches not equipped with air conditioning, and the "REV" switch is omitted on coaches equipped with hydraulic transmission. The "TREADLE CUT OUT" switch at rear end of panel is used in conjunction with special door controls on some Transit Models. Refer to AIR CONDITIONING (SEC. 26) for operation of ventilation and air conditioning switch. Refer to applicable section in group 3 for operation of the defroster switch and the special equipment treadle cut-out switch.

Typical recessed switch panels for Transit and Suburban models are shown in lower views in figure 2. The "DOME" and "BUZZER" switches are common to all models. Other switches shown are used only on specific models or as special equipment as indicated in the legend below the illustrations. Refer to "LIGHTING SYSTEM" in this



TYPICAL DRIVER'S CONTROL PANEL



(TRANSIT)

(SUBURBAN)

TYPICAL RECESSED SWITCH PANELS

1 *Treadle Cut Out Switch
2 Emergency Stop Switch
3 *Air Conditioning Control Switch
4 Master Switch
5 Defroster Switch
6 Starter Switch
7 Reverse Switch (TDM & SDM)
8 Door Master Switch (Transit)
9 Dome Light Switch
10 Standby Sign Switch (Transit)
11 Buzzer Switch
12 Blower Switch (Not used w/Air Cond.)
13 *Headlamp Switch (Used only on vehicles with separate headlamp switch)

*Special Equipment.

TPM-9283

Figure 2—Driver's Control Panel and Recessed Switch Panels

group for use of all light switches. Refer to applicable section in group 3 for use of door master, blower, and buzzer switches.

"MASTER" SWITCH OPERATION

Switch is marked "MASTER" with circuit positions marked "OFF," "DAY," "NITE," and "PARK." Selected circuits become energized when circuit caption on switch is rotated into alignment with position indicator button on control panel. Switch positions, together with the various circuits controlled by each position, are listed below. In some cases, "MASTER" switch merely provides a feed to a circuit which is actually controlled by another switch or relay. Refer to "Engine Control and Generator Wiring Diagrams" for schematic diagrams of master control switch operation.

MASTER SWITCH POSITIONS

"OFF" Position
- No circuits are energized.

"DAY" Position:
- Engine controls and alarm system
- Generating system controls
- Starting system controls
- Transmission controls
- Door controls
- Stop and directional light controls
- Speedometer circuit
- Emergency door alarm system
- Heating system (when engine is running)
- Air conditioning (special equipment) (controlled by separate switch when engine is running)
- Fare box light

"NITE" Position:
- All circuits listed under "DAY" position
- Instrument panel lights
- Marker lights
- Headlights
- Taillights
- Emergency door light
- License plate light
- Rear step light (TDH & TDM)
- Front step light (operated through door switch)
- Entrance door dome light
- Rear lounge seat lights (SDH & SDM)
- Fluorescent dome and destination sign lights (TDH & TDM)
- Destination sign standby lights - TDH & TDM (operated by "STANDBY SIGN" switch on recessed switch panel)

"PARK" Position:
- Marker lights
- Taillights
- License plate light
- Front and rear step lights
- Destination sign standby lights (TDH & TDM)
- Instrument panel lights
- Emergency door light
- Rear lounge seat lights (SDH & SDM)

NOTE: Additional special equipment lights and other special electrical equipment may also be controlled by the various master switch positions.

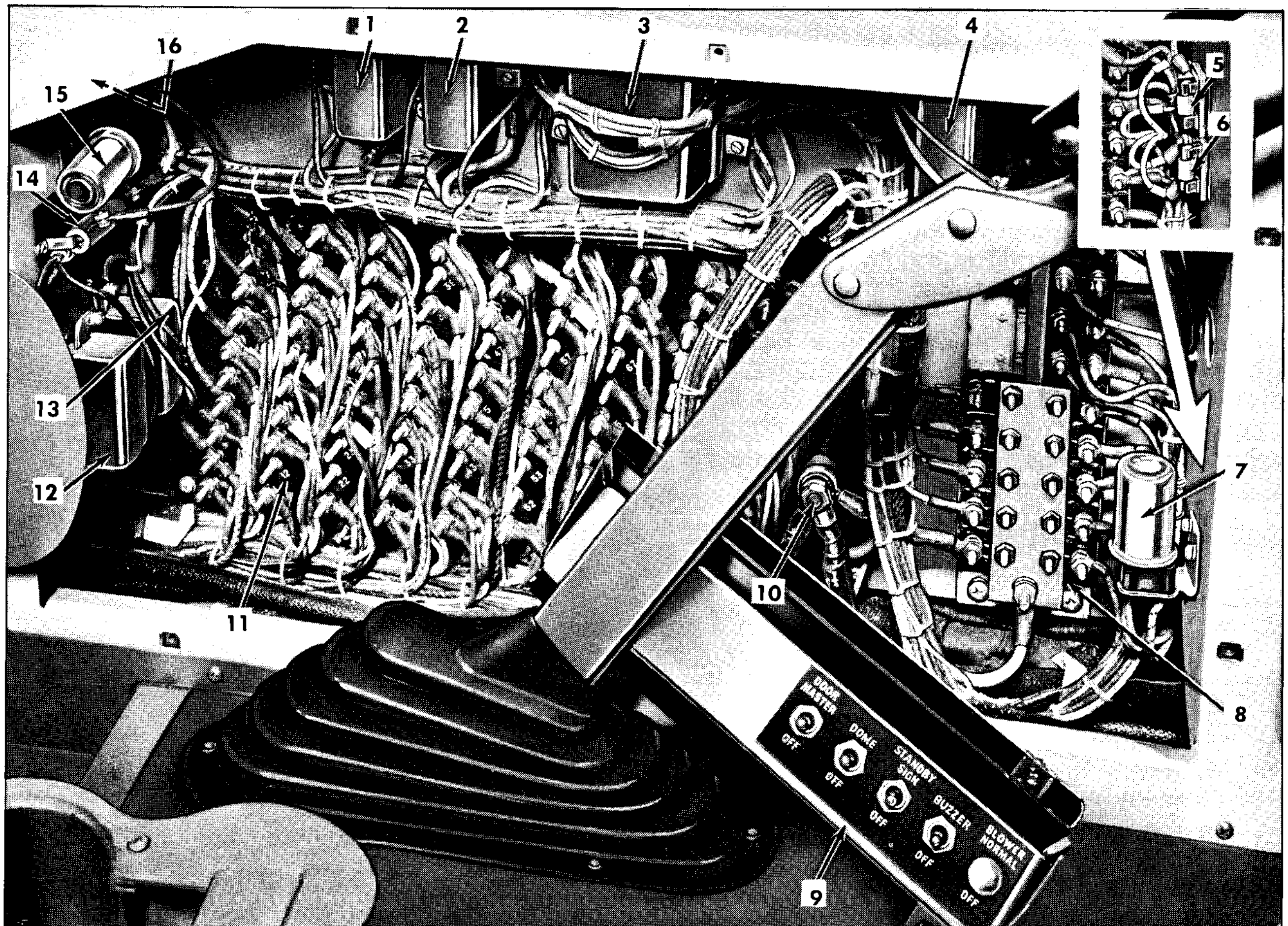
DRIVER'S CONTROL PANEL JUNCTIONS

Junction panel, located below the control panel at left of driver, is accessible after removing the junction, circuit breaker, and electrical apparatus panel cover (fig. 3). Junction panel contains 90 terminal posts, numbered consecutively from 1 through 90. Numbers on panel correspond to numbers on Wiring Diagrams and in tabulations which follow. The tabulation lists each terminal number, the circuit it carries, and the size, color, and pattern of the wire which connects to each terminal. Some of the unused terminals, marked "Open" or "Spare" in the tabulation, are available for use with additional special electrical equipment. Driver's control panel junction numbers appear in the symbol on Wiring diagrams.

Terminal No.	Circuit	Wire Size & Color
1	Directional Switch Amphenol "B" to Engine Comp't. Jct. 1 . .	No. 16 Nat. - Red Cr. Tr.
2	Emergency Stop Switch to Engine Comp't. Jct. 2	No. 12 Red - 2 Nat. // Tr.
3	Transmission Control - TDH & SDH	
	No. 20 Driver's Control Panel Circuit Breaker to Shift Switch "Comm"	No. 16 Nat. - 2 Red // Tr.
	Transmission Control - TDM & SDM	
	No. 20 Driver's Control Panel Circuit Breaker to Reverse Switch	No. 16 Nat. - 2 Red // Tr.
4	*Air Conditioning Control	
	Air Conditioning Switch Terminal 4 to Spliced Connection (See Air Conditioning Wiring Diagram)	No. 14 Nat. - Red Ch.
5	Oil Pressure Gauge (if used) to Engine Comp't. Jct. 5	No. 16 Nat. - Blk. & Grn. // Tr.

*Special Equipment.

WIRING AND MISC. ELEC.



1	Door Control Relay (Transit Models)	9	Recessed Switch Panel
2	Horn Relay	10	Control Panel Battery Junction
3	Alarm Buzzer and Rectifier	11	Junction Panel
4	Dome Lamp Relay (Transit Models)	12	Destination Sign Relay (Transit Models)
5	*Hot Engine Tell-tale Rectifier	13	*Blower Relay (Used w/Air Conditioning)
6	*Low Oil Tell-tale Rectifier	14	Stop Lamp Resistor
7	*Emergency Flashing System Flasher	15	Directional Signal Flasher
8	Circuit Breaker Panel	16	Generator Tell-tale Resistor

*Special Equipment. TPM-9282

Figure 3—Driver's Control Panel Junctions, Circuit Breakers, and Electrical Apparatus

DRIVER'S CONTROL PANEL JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
6	Lighting System	
	From No. 13 Driver's Control Panel Circuit Breaker	No. 14 Nat. - Blk. Tr.
	To Marker Lights, Taillights, etc.	No. 14 Nat. - Blk. Tr.
	To Instrument Panel Lights	No. 16 Nat. - Blk. Tr.
7	Speedometer Amphenol "D" to Engine Comp't. Jct. 7	No. 16 Brn. - Nat. & Blk. Cr. Tr.
8	Door Control - TDH & TDM	
	From Door Control Valve Switch "N.D."	No. 14 Blue - Nat. Tr.
	To Door Control Relay "VAC"	No. 16 Blue - Nat. Tr.
9	Spare to Engine Compartment Jct. 26	No. 14 Yellow
10	Directional Flasher "P" to Directional Lamp Tell-tale	No. 16 Nat. - Red & Grn. Cr. Tr.
11	From Directional Switch Amphenol "D"	No. 16 Black - Nat. Tr.
	To Engine Compartment Jct. 11	No. 14 Black - Nat. Tr.
12	Open	

DRIVER'S CONTROL PANEL JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
13	Transmission Controls - TDH & SDH	
	Shift Switch "N.C." to Engine Comp't. Jct. 13	No. 16 Green
	Transmission Controls - TDM & SDM	
	Reverse Switch to Engine Compartment Jct. 13	No. 16 Green
14	From Blower Sw. or *Air Conditioning Switch Terminal . . .	No. 14 Blk. - Nat. Cr. Tr.
	To Regulator and Blower Control Jct. 3	No. 14 Black
15	Temperature Gauge (if used) to Engine Comp't. Jct. 15 . . .	No. 16 Nat. - Blk. & Red Cr. Tr.
16	Lighting System - TDH & TDM	
	From Dome Lamp Relay "SOL" to Power Supply Unit "+" .	No. 14 Blk. - Red Tr.
	Lighting System - SDH & SDM	
	From Dome Lamp Switch to Dome Lamps	No. 14 Blk. - Red Tr.
17	Speedometer Amphenol "A" to Engine Comp't. Jct. 17	No. 16 Nat. - Blk. & Red // Tr.
18	Exit Door Tell-tale & Brake Interlock (TDH & TDM)	
	From Exit Door Jct. 2	No. 14 Brn. - Red Tr.
	To Brake Magnet Valve	No. 16 Brn. - Red Tr.
	To Exit Door Tell-tale	No. 16 Brn. - Red Tr.
19	Starter Control - TDH & SDH	
	Starter Sw. to Neutral Safety Sw. & Engine Comp't. Jct. 19	No. 16 Red - Grn. Tr.
	Starter Control - TDM & SDM	
	Starter Switch to Engine Compartment Jct. 19	No. 16 Red - Grn. Tr.
20	*Overrule Sw. (Eng. Automatic Shut-off) to Eng. Compt. Jct. 22	No. 14 Brn. - Nat. Cr. Tr.
21	Directional Sw. Amphenol "E" to Engine Comp't. Jct. 21 . .	No. 16 Nat. - Blk. Cr. Tr.
22	Open	
23	Open	
24	*Air Conditioning Control	
	From Air Conditioning Switch Terminal 3	No. 14 Green
	To Regulator & Blower Control Jct. 4	No. 14 Black
25	Low Oil Tell-tale to Alarm Buzzer & Eng. Comp't. Jct. 25 .	No. 16 Nat. - Blk. & Grn. Cr. Tr.
26	Lighting System - TDH & TDM	
	From No. 15 Driver's Control Panel Circuit Breaker to Standby Sign Switch and Front Door Jct. 6	No. 16 Brn. - Blk. Cr. Tr.
	Lighting System - SDH & SDM	
	From No. 14 Driver's Control Panel Circuit Breaker to Front Door Jct. 6	No. 16 Brn. - Blk. Cr. Tr.
27	Speedometer Amphenol "B" to Engine Comp't. Jct. 27	No. 16 Grn. - 2 Red // Tr.
28	Spare to Exit Door Jct. 4 (TDH & TDM)	No. 14 Blue - 2 Nat. // Tr.
29	Starter Controls - TDH & SDH	
	Neutral Safety Sw. "N.D." to Eng. Comp't. Jct. 29 . . .	No. 16 Red - 2 Grn. // Tr.
	Starter Controls - TDM & SDM	
	From No. 18 Driver's Control Panel Circuit Breaker . .	No. 14 Natural
	To Engine Compartment Jct. 29	No. 16 Red - 2 Grn. // Tr.
30	Directional Lamp Flasher "L" to Directional Sw. Amphenol "G"	No. 16 Nat. - 2 Blk. // Tr.
31	Stop Lamp Tell-tale to Engine Compartment Jct. 31	No. 16 Red - Blk. Tr.
32	Engine Control	
	No. 17 Driver's Control Panel Circuit Breaker to Engine Compartment Jct. 32	No. 16 Grn. - Red Tr.
33	Open	
34	*Air Conditioning Stop Tell-tale -- From Hi-Lo Pressure Sw. "MI" to Air Conditioning Stop Tell-tale	No. 16 Nat. - Red Ch.
35	Hot Eng. Tell-tale to Alarm Buzzer 4 & Eng. Comp't. Jct. 35	No. 16 Yellow
36	Lighting System	
	From No. 9 Driver's Control Panel Circuit Breaker . .	No. 14 Blk. - 2 Grn. // Tr.
	To Dimmer Switch	Black
37	Speedometer Amphenol "C" to Engine Comp't. Jct. 37	No. 16 Blk. - 2 Brn. // Tr.
38	Spare to Exit Door Jct. 10 (TDH & TDM)	No. 14 Blue - Nat. Cr. Tr.
39	Open	
40	From Alarm Buzzer 3 to Engine Comp't. Jct. 40	No. 14 Brn. - Nat. Tr.
	To Engine Stop Time Delay Relay Rectifier	No. 14 Black
41	Directional Signals	
	Directional Sw. Amphenol "A" to Right Front Directional Lamp	No. 16 Orange - Grn. Tr.
	To *Right Side Directional Lamp (When Used)	Plain
42	Charging Circuit	
	From Engine Compartment Jct. 42	No. 12 Brn. - Blk. Tr.
	To Blower Switch (Std.)	No. 14 Brown
	To Modulating Valve Sw. (Std.)	No. 16 Brown
	*Feed to Air Condition Sw. "BAT" (with Air Cond.) . . .	No. 12 Brown
	*To Driver's Control Panel Circuit Breaker No. 12 (with Air Conditioning)	No. 14 Natural

*Special Equipment.

DRIVER'S CONTROL PANEL JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
43	Open	
44	Defroster Control	
	Defroster Switch "1" to Defroster Motor "A"	No. 12 Natural
	To Modulating Valve Switch	No. 16 Natural
45	Low Air Tell-tale to Alarm Buzzer 2 and Low Air Switch . .	No. 16 Red - Nat. Tr.
46	Lighting System	
	From Dimmer Switch "LO"	Natural
	To Headlight Low Beams	No. 16 Nat. - Grn. Tr.
47	Open	
48	Door Control (TDH & TDM)	
	From Door Master Sw. to Door Control Valve Sw. "COM," to Exit Door Jct. 5, and to Front Door Jct. 7	No. 14 Blk. - Grn. Ch.
49	Speedometer	
	Feed From No. 16 Driver's Control Panel Circuit Breaker to Engine Compartment Jct. 36	No. 14 Maroon
50	Reading Lamps (SDH & SDM)	
	From Dome Lamp Switch	No. 14 Blk. - Red Ch.
	To Regulator & Blower Control Jct. 6	No. 14 Black
51	Directional Signals	
	Directional Sw. Amphenol "F" to Left Front Directional Lamp	No. 16 Orange - Blk. Tr.
	To *Left Side Directional Lamp (When Used)	Plain
52	Open	
53	Open	
54	Defroster Switch "2" to Defroster Motor "F"	No. 14 Grn. - Nat. Tr.
55	Emergency Door Tell-tale to Alarm Buzzer 1 and Emergency Door Switch	No. 16 Blue - Blk. Tr.
56	Lighting System	
	From Dimmer Switch "HI"	Red
	To Headlight Hi-Beams	No. 14 Nat. - Grn. Cr. Tr.
	To Hi-Beam Tell-tale	No. 16 Nat. - Grn. Cr. Tr.
57	Open	
58	Spare to Exit Door Jct. 15 (TDH & TDM)	No. 14 Brn. - Grn. Tr.
59	Regulator Sensing Control Relay "S" to No-Charge Tell-tale .	No. 16 Black
60	Spare to Exit Door Jct. 13	No. 16 Brn. - 2 Nat. // Tr.
61	Directional Sw. Amphenol "C" to Stop Lamp Resistor	No. 16 Natural
62	Lighting System (TDH & TDM)	
	From No. 14 Driver's Control Panel Circuit Breaker to Front Door Jct. 9	No. 16 Grn. - Blk. Cr. Tr.
63	Open	
64	Blower Switch to Modulating Valve Switch (Std.)	No. 16 Blk. - Brn. Tr.
	*With Air Cond. - Blower Relay "VAC" to Modulating Valve Switch "N.C."	No. 16 Blk. - Brn. Tr.
65	Alarm & Signal Controls	
	From No. 19 Driver's Control Panel Circuit Breaker . .	No. 14 Nat. - 2 Grn. // Tr.
	To Alarm Buzzer "BAT"	No. 16 Nat. - 2 Grn. // Tr.
	To Emergency Door Tell-tale	No. 16 Blue - Blk. Tr.
	To Engine & Low Air Alarm Tell-tales and to Gauges . .	No. 16 Nat. - 2 Grn. // Tr.
66	Spare (*Driver's Lamp)	No. 16 Brn. - Nat. Cr. Tr.
67	Open	
68	Spare to Front Door Jct. 4	No. 14 Grn. - Red Ch.
69	Spare to Engine Compartment Jct. 46	No. 14 Blue
70	Open	
71	Open	
72	Open	
73	Spare (in head lamp harness)	No. 16 Red - 2 Blk. // Tr.
74	Spare (*Driver's Fan)	No. 16 Blk. - Red Tr.
75	Buzzer Switch to Passenger Signal	No. 16 Orange - Nat. Tr.
76	Open	
77	Horn Relay "D" to Horn	No. 10 Brn. - Blk. & Red Cr. Tr.
78	Spare (Door Control Valve Sw. "N.C." to Exit Door Jct. 11) .	No. 14 Brn. - 2 Blk. // Tr.
79	Spare (in head lamp harness)	No. 14 Orange - 2 Grn. // Tr.
80	Ground	Black
81	Transmission Low Oil Tell-tale (TDM & SDM)	
	From No. 20 Driver's Control Panel Circuit Breaker . .	No. 16 Natural
	To Transmission Low Oil Tell-tale	No. 16 Grn. - 2 Blk. // Tr.
82	Spare to Engine Comp't. Jct. 8	No. 16 Yellow - Blue Tr.

*Special Equipment.

DRIVER'S CONTROL PANEL JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
83	Spare(in head lamp harness)	No. 16 Red - Grn. Cr. Tr.
84	Transmission Low Oil Tell-tale (TDM & SDM)	
	Transmission Low Oil Tell-tale to Eng. Comp't. Jct. 18	No. 16 Blk. - Grn. Tr.
85	Passenger Signal Switches to Passenger Signal	No. 16 Orange
86	Spare to Engine Compartment Jct. 28	No. 16 Brn. - Blk. & Red Cr. Tr.
87	Horn Button to Horn Relay "S"	No. 16 Brn. - Red Ch.
88	Door Control (TDH & TDM)	
	From Door Control Relay "SOL" to Front Door Jct. 8 and Exit Door Jct. 9	No. 14 Blue - Red Tr.
89	Spare to Engine Compartment Jct. 38	No. 16 Grn. - Blk. Tr.
90	Ground - From Front Door Jct. 2 and Exit Door Jct. 14	Black

DRIVER'S CONTROL PANEL CIRCUIT BREAKERS

Circuit breaker panel, located on the apparatus panel at left of driver's seat, is accessible after removing the panel cover (fig. 3). Panel has space for 20 circuit breakers, however, they are not all used on coaches with standard electrical equipment. Additional circuit breakers may be used with special equipment; for example, No. 12 shown in figure 4 is used with air conditioning. Circuit breakers No. 8 and 11 are not used on SDH & SDM models.

Circuit breakers are automatic reset type, protecting various circuits as indicated in the tabulation which follows. Any condition which causes an overload on a circuit, such as a short, will cause circuit breaker bimetal element to open the circuit; when the element cools, circuit breaker will again close the circuit. This off and on cycle will repeat until the switch controlling the defective circuit is turned off, or until the cause of the overload has been located and corrected. In the event a circuit breaker becomes defective (burns out or sticks closed), the defective circuit breaker must be replaced.

Circuit breaker numbers shown on Wiring Diagrams and in the tabulation which follows do not appear on the circuit breakers or on the panel; to identify circuit breakers, it is necessary to refer to diagram shown in figure 4. Amperage rating of each circuit breaker is also shown in figure 4. Circuit breakers must be installed so the feed or battery wire (or bus bar) connects to the "BAT" or short terminal, and the wire carrying the circuit to the electrical units connects to the "AUX." or long terminal.

All circuit breakers connected by the bus bar (figs. 3 and 4) are fed from number 1 terminal on "MASTER" switch and are energized whenever the "MASTER" switch is in either "DAY" or "NITE" position.

The tabulation on next page lists each circuit breaker number (as identified in figure 4), the circuit it protects, and the size, color, and pattern of the wire (or wires) which connect to the circuit breaker terminals.

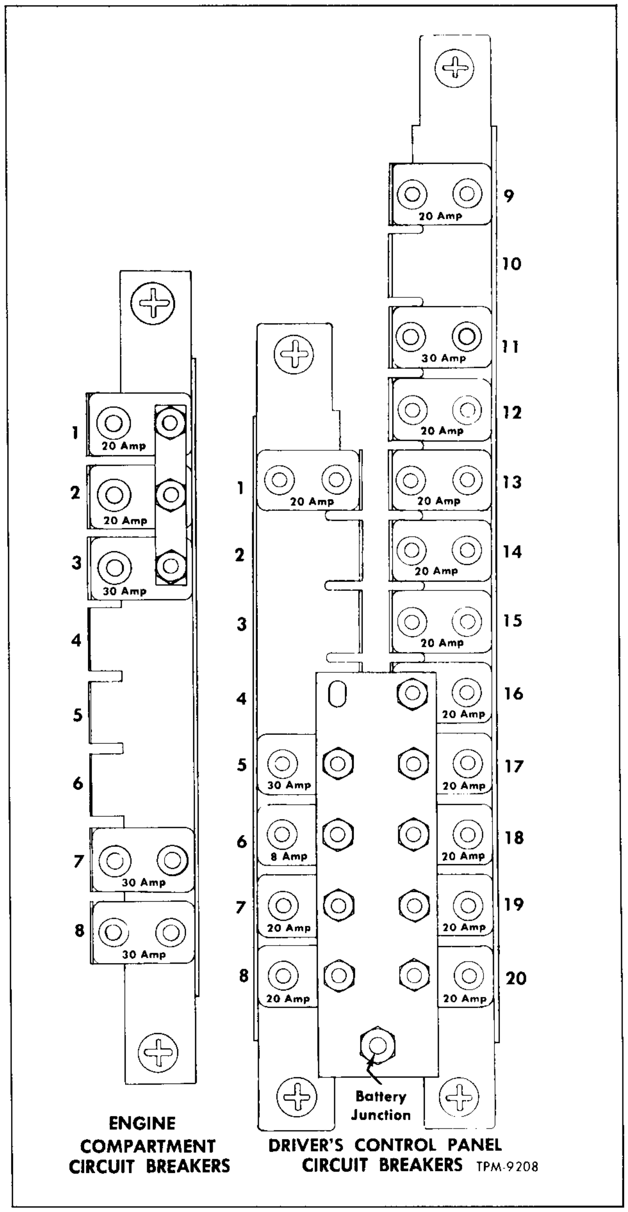


Figure 4—Circuit Breaker Identification

DRIVER'S CONTROL PANEL CIRCUIT BREAKERS (CONT'D)

Circuit Breaker No.	Circuit	Wire Size & Color	Fed From
1	Feed From Control Panel Battery Jct.	No. 10 Red	Battery
	To Destination Sign Relay "BAT" (TDH & TDM)	No. 14 Red - Blk. Cr. Tr.	
	To Dome Lamp Switch	No. 14 Red - Blk. Cr. Tr.	
	To Horn Relay "B"	No. 10 Red - Nat. Cr. Tr.	
2	Open		
3	Open		
4	Open		
5	Defroster Switch	No. 12 Blk. - Red Tr.	No. 1 on Master Sw.
6	Directional Signal Flasher	No. 16 Blk. - Yellow Ch.	No. 1 on Master Sw.
7	Buzzer Switch	No. 16 Orange - Nat. Tr.	No. 1 on Master Sw.
8	Door Control Relay "BAT" and Door Master Sw. (TDH & TDM)	No. 14 Blk. Grn. Ch.	No. 1 on Master Sw.
9	Destination Sign and Headlights		
	From No. 3 on Master Switch	No. 14 Blk. - 2 Grn. // Tr.	No. 3 on Master Sw.
	To Driver's Control Panel Jct. 36	No. 14 Blk. - 2 Grn. // Tr.	
	To Destination Sign Relay "VAC" (TDH & TDM)	No. 16 Blk. - 2 Grn. // Tr.	
	To Dome Lamp Sw. (SDH & SDM)	No. 14 Blk. - 2 Grn. // Tr.	
10	Open		
11	Dome Lamp Relay (TDH & TDM)	No. 14 Black	Battery
12	Blower Relay (Air Conditioning)		
	From Driver's Control Panel Jct. 42	No. 14 Natural	Battery
	To Blower Relay "BAT"	No. 14 Grn. - 2 Blk. // Tr.	
13	Step, Instrument, Marker, & Tail Lamps	No. 14 Nat. - Blk. Tr.	No. 2 on Master Sw.
14	Front Door Switch		
	From No. 5 on Master Switch	No. 14 Grn. - Blk. Cr. Tr. (TDH & TDM)	No. 5 on Master Sw.
		No. 14 Brn. - Blk. Cr. Tr. (SDH & SDM)	No. 5 on Master Sw.
	To Driver's Control Panel Jct. 62 (TDH & TDM)	No. 16 Grn. - Blk. Cr. Tr.	
	To Driver's Control Panel Jct. 26 (SDH & SDM)	No. 16 Brn. - Blk. Cr. Tr.	
15	Destination Sign Standby Lamps and Switch (TDH & TDM)	No. 16 Brn. - Blk. Cr. Tr.	No. 4 on Master Sw.
	Dome Lamp Switch (SDH & SDM)	No. 14 Brn. - Blk. & Red Cr. Tr.	No. 4 on Master Sw.
16	Speedometer Feed	No. 14 Maroon	No. 1 on Master Sw.
17	Engine Controls	No. 16 Grn. - Red Tr.	No. 1 on Master Sw.
18	Starter Switch	No. 16 Red - Grn. Tr.	No. 1 on Master Sw.
19	Alarm System & Gauges	No. 14 Nat. - 2 Grn. // Tr.	No. 1 on Master Sw.
20	Transmission Controls		
	To Driver's Control Panel Jct. 3 (Shift Lever Sw. on TDH & SDH; Reverse Sw. on TDM & SDM)	No. 16 Nat. - 2 Red // Tr.	No. 1 on Master Sw.
	To Driver's Control Panel Jct. 81 (Trans. Low Oil Tell-tale (TDM & SDM)	No. 16 Natural	No. 1 on Master Sw.

NOTE: All Circuit Breakers Fed From No. 1 Terminal on Master Switch are Connected by a Bus Bar.

ENGINE COMPARTMENT APPARATUS BOX

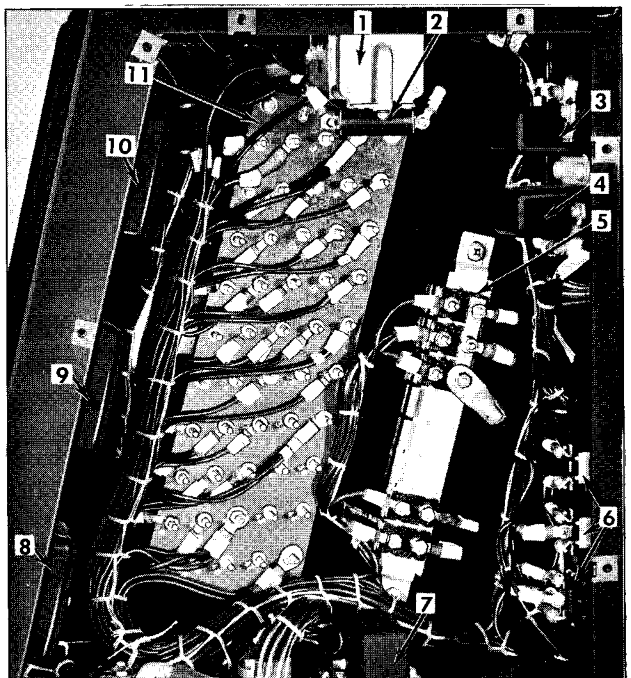
Engine compartment apparatus box is located at right rear corner of coach in top of engine compartment. Junctions, circuit breakers, and electrical units installed in the box are accessible after the apparatus box cover is removed (fig. 5). The following units are installed in engine compartment apparatus box:

*Engine stop time delay relay
*Engine stop time delay relay rectifier
Engine modulating relay (TDH & SDH)
*Air conditioning control relay
Stop light tell-tale relay
Starter control and generator relay
Transmission control relay (TDH & SDH)
Reverse relay (TDM & SDM)
Engine compartment junction panel
Engine compartment circuit breaker panel
Engine control switch, starter switch, and engine compartment light switch are mounted on rear edge of apparatus box.
*Special Equipment.

ENGINE COMPARTMENT JUNCTION PANEL

Junction panel in engine compartment apparatus box (fig. 5) contains 48 terminal posts numbered consecutively from 1 through 48. Numbers on panel correspond to numbers on Wiring Diagrams and in the tabulation which follows: The tabulation lists each terminal number, the circuit it carries, and the size, color, and pattern of the wires which connect to the terminal. Some of the unused terminals, marked "Open" or "Spare" in the tabulation, may be used for additional electrical equipment.

NOTE: Wires leading from the junction panel into the engine compartment are covered with a special black heat-resistant insulation. A tag near end of each black wire identifies the terminal to which it connects. Engine compartment junction panel numbers appear in the symbol ☐ on Wiring Diagrams.



1 *Engine Stop Time Delay Relay
2 *Time Delay Relay Rectifier
3 Engine Modulating Relay (TDH & SDH)
4 Reverse Relay (TDM & SDM)
5 Circuit Breakers
6 Engine Compartment Switches
7 Stop Lamp Relay
8 Starter Control and Generator Relay
9 Transmission Control Relay (TDH & SDH)
10 Air Conditioning Control Relay
11 Junction Panel

* Special Equipment.

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Figure 5—Engine Compartment Apparatus Box

ENGINE COMPARTMENT JUNCTIONS

Terminal No.	Circuit	Wire Size & Color
1	R.H. Stop & Directional Light	
	From Driver's Control Panel Jct. 1	No. 16 Nat. - Red Cr. Tr.
	To Engine Closure Door Amphenol "A"	No. 16 Black
2	Emergency Stop	
	From Driver's Control Panel Jct. 2	No. 12 Red - 2 Nat. // Tr.
	To Engine Amphenol "H"	No. 12 Black
3	Open	
4	*Air Conditioning Controls	
	From Low Air Switch	No. 14 Brn. - Blk. & Red Cr. Tr.
	To Oil Pressure Switch	No. 16 Black
5	*Engine Oil Pressure Gauge	
	From Driver's Control Panel Jct. 5	No. 16 Nat. - Blk. & Grn. // Tr.
	To Oil Pressure Sending Unit	No. 16 Black
6	Tail & License Lamps	
	From Spliced Junction	No. 16 Nat. - Blk. Tr.
	To Engine Closure Door Amphenol "C"	No. 16 Black
7	Speedometer	
	From Transmission Amphenol "B"	No. 16 Black
	To Driver's Control Panel Jct. 7	No. 16 Brn. - Nat. & Blk. Cr. Tr.
8	Spare From Driver's Control Panel Jct. 82	No. 16 Yellow - Blue Tr.
9	Generator-Regulator Field Circuit	
	From Regulator & Blower Control Jct. 5 to Engine Amphenol "A"	No. 14 Black

*Special Equipment.

ENGINE COMPARTMENT JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
10	Open	
11	Stop Lamp	
	From Driver's Control Panel Jct. 11	No. 14 Blk. - Nat. Tr.
	To Stop Lamp Relay "S"	No. 14 Black
12	Open	
13	Transmission Controls	
	From Driver's Control Panel Jct. 13	No. 16 Green
	TDM & SDM - To Reverse Relay "VAC"	No. 16 Black
	TDH & SDH - To Transmission Relay "3"	No. 16 Black
14	*Air Conditioning Control	
	Air Conditioning Control Relay to Oil Pressure Switch	No. 16 Black
	To Hi-Lo Pressure Switch "M2"	No. 16 Blk. - Yellow Ch.
15	*Engine Temperature Gauge	
	From Driver's Control Panel Jct. 15	No. 16 Nat. - Blk. & Red Cr. Tr.
	To Engine Amphenol "E"	No. 16 Black
16	Engine Comp't. Lamp Sw. to Engine Compartment Lamps	No. 16 Black
17	Speedometer	
	From Transmission Amphenol "A"	No. 16 Black
	To Driver's Control Panel Jct. 17	No. 16 Nat. - Blk. & Red // Tr.
18	Transmission Low Oil Tell-tale (TDM & SDM)	
	From Driver's Control Panel Jct. 84	No. 16 Blk. - Grn. Tr.
	To Transmission Amphenol "F"	No. 16 Black
19	Starter Control	
	From Driver's Control Panel Jct. 19	No. 16 Red - Grn. Tr.
	To Engine Compartment Starter Switch "OFF"	No. 16 Black
20	Spare From Driver's Control Panel Jct. 20	No. 14 Brn. - Nat. Cr. Tr.
21	Stop & Directional Lights	
	From Driver's Control Panel Jct. 21	No. 16 Nat. - Blk. Cr. Tr.
	To Engine Closure Door Amphenol "B"	No. 16 Black
22	Engine Controls	
	TDH & SDH - Engine Modulating Relay "D" to Engine Stop Solenoid Valve	No. 16 Black
	TDM & SDM - Engine Comp't. Engine Control Switch to Engine Stop Solenoid Valve	No. 16 Black
	*Engine Stop Overrule (when used) to Driver's Control Panel Jct. 20	No. 14 Brn. - Nat. Cr. Tr.
23	Spare to Engine Comp't. Engine Control Switch "OFF"	No. 16 Black
24	*Air Conditioning Control	
	From Air Conditioning Control Relay "5"	No. 14 Black
	To Air Conditioning Clutch Solenoid	No. 14 Blk. - Brn. Tr.
25	Low Oil Alarm	
	From Driver's Control Panel Jct. 25	No. 16 Nat. - Blk. & Grn. Cr. Tr.
	To Low Oil Pressure Switch	No. 16 Black
26	Spare From Driver's Control Panel Jct. 9	No. 14 Yellow
27	Speedometer	
	From Transmission Amphenol "D"	No. 16 Black
	To Driver's Control Panel Jct. 27	No. 16 Grn. - 2 Red // Tr.
28	Spare From Driver's Control Panel Jct. 86	No. 16 Brn. - Blk. & Red Cr. Tr.
29	Starter Control	
	From Driver's Control Panel Jct. 29	No. 16 Red - 2 Grn. // Tr.
	To Engine Compartment Starter Switch "NORMAL"	No. 16 Black
30	Engine Comp't. Circuit Breaker No. 2 to Stop Lamp Sw.	No. 14 Black
31	Stop Lamp Tell-tale	
	From Stop Lamp Relay "D"	No. 16 Black
	To Driver's Control Panel Jct. 31	No. 16 Red - Blk. Tr.
32	Engine Control	
	From Driver's Control Panel Jct. 32	No. 16 Grn. - Red Tr.
	To Engine Comp't. Engine Control Switch "NORMAL"	No. 16 Black
33	Open	
34	*Air Conditioning Control	
	From Hi-Lo Pressure Switch "L2"	No. 16 Yellow - Blk. Cr. Tr.
	To Air Conditioning Control Relay "3" & "4"	No. 16 Black
35	Engine Overheat Alarm	
	From Driver's Control Panel Jct. 35	No. 16 Yellow
	To Engine Amphenol "C"	No. 16 Black
36	Speedometer	
	From Driver's Control Panel Jct. 49	No. 14 Maroon
	To Transmission Amphenol "E"	No. 14 Black

*Special Equipment.

ENGINE COMPARTMENT JUNCTIONS (CONT'D)

Terminal No.	Circuit	Wire Size & Color
37	Speedometer	
	From Transmission Amphenol "C"	No. 16 Black
	To Driver's Control Panel Jct. 37	No. 16 Black - 2 Brn. // Tr.
38	Spare From Driver's Control Panel Jct. 89	No. 16 Grn. - Blk. Tr.
39	Open	
40	Spare From Driver's Control Panel Jct. 40	No. 14 Brn. - Nat. Tr.
41	Stop Lamp Switch to Stop Lamp Relay "B"	No. 14 Black
42	Charging Circuit	
	From Driver's Control Panel Jct. 42	No. 12 Brn. - Blk. Tr.
	To Engine Comp't. Circuit Breaker No. 7	No. 14 Black
43	Open	
44	Open	
45	Open	
46	Spare From Driver's Control Panel Jct. 69	No. 14 Blue
47	Open	
48	Ground	Black

*Special Equipment

ENGINE COMPARTMENT CIRCUIT BREAKERS

Circuit breaker panel in engine compartment apparatus box (fig. 5) has spaces for eight automatic reset type circuit breakers, however, only five are used on vehicles by this manual.

Circuit breakers protect various electrical circuits as indicated in the tabulation which follows. Any condition which causes an overload on a circuit will cause the circuit breaker bimetal element to open the circuit; when the element cools, circuit breaker will again close the circuit. This off and on cycle will repeat until the switch controlling the defective circuit is turned off, or until the cause of the overload has been located and corrected. In the event a circuit breaker becomes defective (burns out or sticks closed), the defective circuit breaker must be replaced. When replacing a circuit breaker, it must be installed so the feed or battery wire connects to the "BAT" or short terminal, and the wires carrying the circuit to the electrical units connects to the "AUX." or long terminal.

Circuit breaker numbers shown on Wiring Diagrams and in the tabulation which follows do not appear on the circuit breakers or on the panel. To identify circuit breakers by number, count from top to bottom, or refer to the diagram in figure 4. The amperage rating of each circuit breaker is also shown in figure 4.

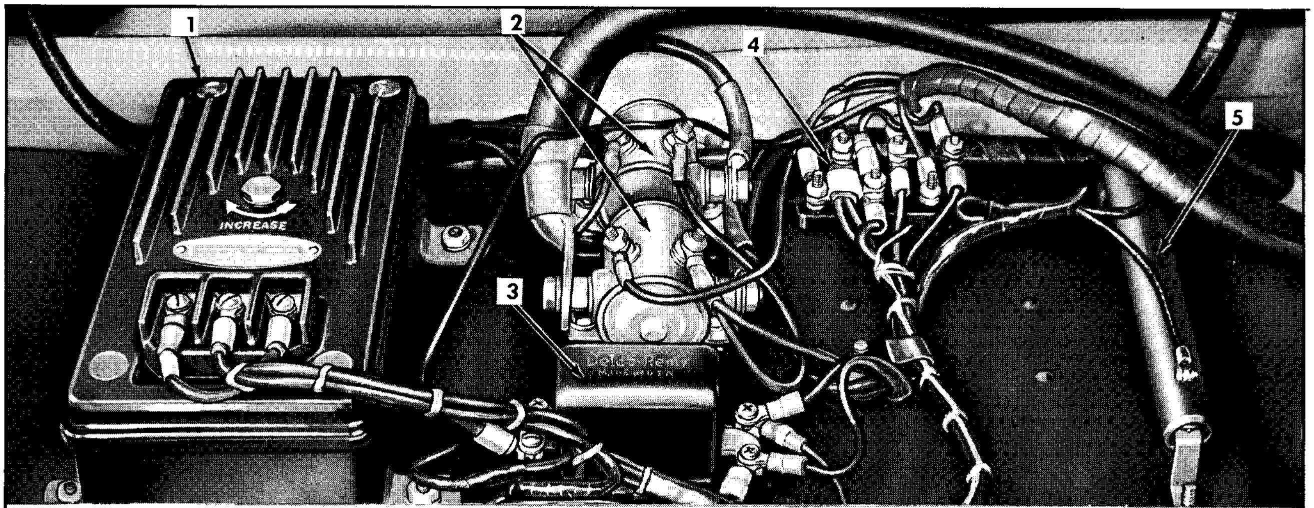
The tabulation which follows lists each circuit breaker number, the circuit it carries, and the size and color of the wire which connects to each terminal. Circuit breaker numbers 1, 2, and 3 are all fed through a bus bar directly from the engine compartment battery junction. Number 7 is fed from number 5 terminal on starter and generator control relay, and number 8 is fed from number 2 terminal on starter and generator control relay.

Circuit Breaker No.	Circuit	Wire Size & Color	Fed From
1	Engine Controls	No. 16 Black	Battery
2	Engine Comp't. Lamps & Stop Lamp Switch	No. 14 Black	Battery
3	Transmission Controls	No. 10 Black	Battery
4	Open		
5	Open		
6	Open		
7	Generator Charging Circuit	No. 14 Black	Generator
8	Starter Controls	No. 10 Black	Starter & Gen. Control Relay

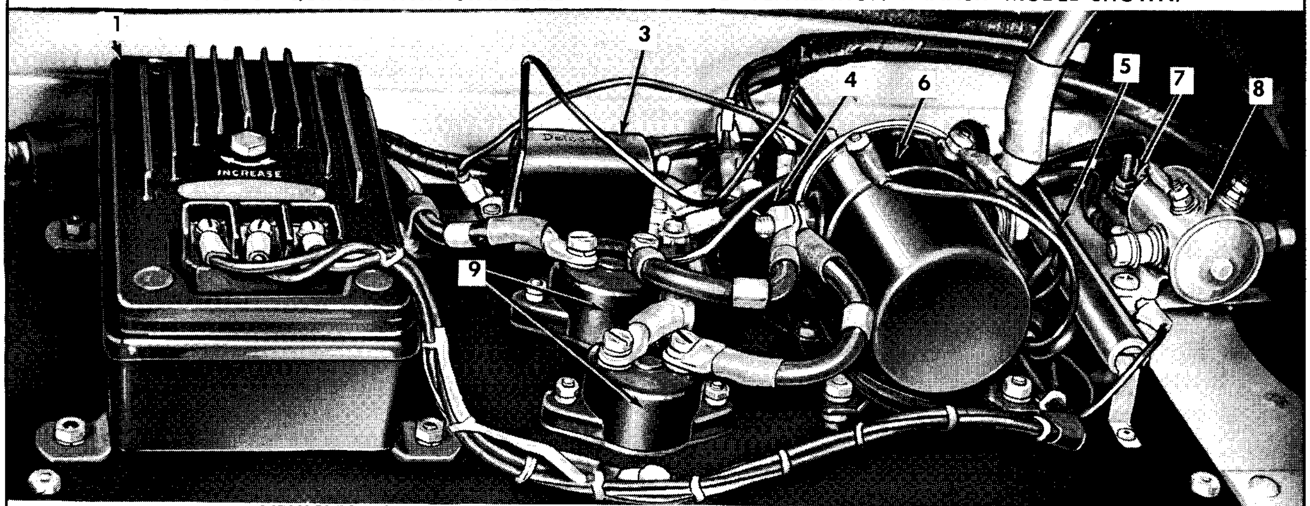
REGULATOR AND BLOWER CONTROL PANEL

Voltage regulator and blower control panel (fig. 6) is mounted on forward side of rear stepwell front crossmember on Transit models, and on forward side of emergency door front bulkhead on Suburban models. Panel is protected by a shield which is hinged at rear end and secured at front end by four bolts. For access to control panel, remove the four bolts, lock washers, and flat washers and swing shield down.

On both Transit and Suburban models equipped with standard heating and ventilation system, the panel contains the voltage regulator, regulator



VEHICLES EQUIPPED WITH STANDARD HEATING AND VENTILATION (TRANSIT MODEL SHOWN)



VEHICLES EQUIPPED WITH AIR CONDITIONING (SUBURBAN MODEL SHOWN)

1 Regulator
2 Blower Control Relays (All Models with Standard Heating & Ventilation)
3 Regulator Sensing Control Relay
4 Junction Block
5 Sensing Control Relay Resistor
6 Blower Control Relay (All Models with Air Conditioning)
7 Reading Light Circuit Breakers (All Suburban Models)
8 Reading Light Relay (All Suburban Models)
9 Blower Motor Circuit Breakers (All Models with Air Conditioning)

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Figure 6—Regulator and Blower Control Panel

sensing control relay, sensing control relay resistor, two blower control relays, and a six-post junction block as shown in the upper view in figure 6; Suburban models also have the reading light relay and two 20-amp reading light relay circuit breakers as shown in the lower view in figure 6.

On both Transit and Suburban models equipped with air conditioning, the panel contains the voltage regulator, regulator sensing control relay and resistor, one blower control relay, two 90-amp blower motor circuit breakers, and a six-post junction block as shown in the lower view in figure 6; the reading light relay and two 20-amp circuit breakers shown in the lower view are used on Suburban models only.

Refer to "REGULATOR" section for information on the transistor type voltage regulator. The tabulation which follows identifies wires connected to the junction block terminals. Terminal post numbers on junction block appear on wiring diagrams in the symbol ◇.

REGULATOR AND BLOWER CONTROL PANEL JUNCTIONS

Terminal No.	Circuit	Wire Size & Color
1	Blower Control Relay to Water Pump Relay "BAT"	No. 12 Black
	To "AMM" Terminal on Regulator Sensing Control Relay	No. 14 Black
2	Regulator Sensing Control Relay "C" to Spliced Jct. in No. 12 Brn. - Blk. Tr. Wire Between Driver's Control Panel Jct. 42 & Eng. Comp't. Jct. 42	No. 16 Black
3	Driver's Control Panel Jct. 14 to Blower Control Relays	No. 14 Black
4	Driver's Control Panel Jct. 24 to Blower Motors (W/Air Cond.*)	No. 14 Black
5	Regulator "FLD" Terminal to Engine Comp't. Jct. 9	No. 14 Black
6	Driver's Control Panel Jct. 50 to Reading Lamp Relay (SDH & SDM)	No. 14 Black

*Special Equipment.

ENTRANCE DOOR JUNCTIONS

Entrance door junction block is mounted in front door engine compartment above door as shown in figure 1 in "DOORS AND CONTROLS" (SEC. 3). Junction block is accessible after opening door engine compartment door. Junction block contains nine terminal posts numbered from 1 through 9. The tabulation which follows lists each terminal number, the circuit it carries, and the size, color, and pattern of the wires which connect to each terminal. Terminal post numbers on the Wiring Diagrams appear in the symbol ▽.

Terminal No.	Circuit	Wire Size & Color
1	From Front Door Switch "COMM"	No. 16 Blue
	To Front Door Step Lamp	Plain
2	Ground Through Driver's Control Panel Jct. 90	No. 14 Black
3	Feed From Driver's Control Panel Circuit Breaker No. 13	No. 14 Nat. - Blk. Tr.
	To Front Door Switch "N.C."	No. 16 Nat. - Blk. Tr.
	To Right Front Corner Marker Light	No. 16 Nat. - Blk. Tr.
	To Front Michigan Marker Lights	No. 16 Natural
	To Right Side Destination Sign *(When Used)	Plain
4	Spare to Driver's Control Panel Jct. 68	No. 14 Grn. - Red Ch.
5	Spare to Exit Door Jct. 16	No. 14 Yellow - 2 Blue // Tr.
6	TDH & TDM - From Driver's Control Panel Jct. 26 to Destination Sign Standby Lamps	No. 16 Brn. - Blk. Cr. Tr.
	SDH & SDM - From Driver's Control Panel Jct. 26 to Front Door Switch "N.O."	No. 16 Grn. - Blk. Cr. Tr.
7	Spare From Driver's Control Panel Jct. 48 & Exit Door Jct. 5	No. 14 Blk. - Grn. Ch.
8	Spare From Driver's Control Panel Jct. 88 & Exit Door Jct. 9	No. 14 Blue - Red Tr.
9	Driver's Control Panel Jct. 62 to Front Door Sw. "N.D." (TDH & TDM)	No. 16 Grn. - Blk. Cr. Tr.

*Special Equipment.

EXIT DOOR JUNCTIONS (TDH & TDM)

Exit door junction block is mounted in exit door engine compartment above door as shown in figure 2 in "DOORS AND CONTROLS" (SEC. 3). Junction block is accessible after opening exit door engine compartment door. Junction block contains 16 terminal posts numbered from 1 through 16. The tabulation which follows lists each terminal number, the circuit it carries, and the size, color, and pattern of the wires which connect to each terminal. Terminal post numbers on the Wiring Diagrams appear in the symbol ◎.

Terminal No.	Circuit	Wire Size & Color
1	Open	
2	Exit Door Sw. Relay "SOL" to Driver's Control Panel Jct. 18	No. 14 Brn. - Red Tr.
	To Exit Door Unlock Lamp	No. 6 Natural
3	Open	
4	Spare to Driver's Control Panel Jct. 28	No. 14 Blue - 2 Nat. // Tr.
5	From Driver's Control Panel Jct. 48 to Exit Door Switch Relay "BAT" and to Exit Door Switch "COM."	No. 14 Blk. - Grn. Ch.
6	Open	
7	Open	
8	Ground (for Special Equipment Folding Doors)	Connected to Jct. 14 by Bus Bar

Continued on next page.

EXIT DOOR JUNCTIONS (TDH & TDM) (CONT'D.)

Terminal No.	Circuit	Wire Size & Color
9	From Driver's Control Panel Jct. 88 to Exit Door Solenoid	No. 14 Blue - Red Tr.
10	Spare to Driver's Control Panel Jct. 38	No. 14 Blue - Nat. Cr. Tr.
11	Spare to Driver's Control Panel Jct. 78	No. 14 Brn. - 2 Blk. // Tr.
12	From Driver's Control Panel Jct. 6	No. 16 Nat. - Blk. Tr.
	To Exit Door Step Lamp	Plain
13	Spare to Driver's Control Panel Jct. 60	No. 16 Brn. - 2 Nat. // Tr.
14	Exit Door Solenoid to Ground thru Driver's Control Panel Jct. 90	No. 14 Black
15	Spare to Driver's Control Panel Jct. 58	No. 14 Brn. - Grn. Tr.
16	Spare From Entrance Door Jct. 5	No. 14 Yellow - 2 Blue // Tr.

AMPHENOL CONNECTORS

Wiring harness connections are made at several points on vehicle through Amphenol multiple plug and receptacle type connectors. Terminals in receptacle and on plug are identified by letters. Locating key in receptacle housing engages a slot in plug to assure proper installation of plug. Letters on plugs and receptacles correspond to letters shown on Wiring Diagrams and in the tabulations which follow. Location of each Amphenol connector, together with the symbols and circuit tabulations, follows:

ENGINE AMPHENOL CONNECTOR

Electrical connections between the terminals, circuit breakers, and electrical units in the engine compartment apparatus box and the engine wiring harness are made through the left receptacle at the bottom of the engine compartment apparatus box.

Refer to symbol on Wiring Diagrams.

Terminal Letter	Circuit	Wire Size & Color
A	Generator "FLD" to Engine Comp't. Jct. 9	No. 14 Black
B	Generator "RELAY" to Starter & Generator Control Relay "4"	No. 14 Black
C	Engine Comp't. Jct. 35 to Engine Overheat Thermostat	No. 16 Black
D	Spare	No. 14 Black
E	Engine Comp't. Jct. 15 to Water Temperature Sending Unit	No. 16 Black
F	Spare	No. 14 Black
G	Spare	No. 14 Black
H	Emergency Stop Solenoid to Engine Comp't. Jct. 2	No. 12 Black
I	Starter Solenoid to No. 8 Engine Comp't. Circuit Breaker	No. 10 Black

TRANSMISSION AMPHENOL CONNECTOR

Electrical connections from the engine compartment apparatus box to the transmission wiring harness are made through the right receptacle at bottom of engine compartment apparatus box.

Refer to symbol on Wiring Diagram.

Terminal Letter	Circuit	Wire Size & Color
A	Speedometer Drive Unit "A" to Engine Comp't. Jct. 17	No. 16 Black
B	Speedometer Drive Unit "B" to Engine Comp't. Jct. 17	No. 16 Black
C	Speedometer Drive Unit "C" to Engine Comp't. Jct. 37	No. 16 Black
D	Speedometer Drive Unit "D" to Engine Comp't. Jct. 27	No. 16 Black
E	Speedometer Feed From Engine Compt. Jct. 36	No. 14 Black
F	Transmission Governor Switch (TDH & SDH)	No. 16 Black
	Transmission Low Oil Pressure Switch (TDH & SDM)	No. 16 Black
G	Transmission Relay "4" to Governor Switch (TDH & SDH)	No. 16 Black
H	Transmission Relay "6" to Neutral Solenoid (TDH & SDH)	No. 10 Black
	Reverse Relay "SOL" to Reverse Solenoid (TDM & SDM)	No. 10 Black
I	Transmission Relay "1" Direct Drive Solenoid (TDH & SDH)	No. 10 Black

AMPHENOL CONNECTORS (CONT'D.)

ENGINE CLOSURE DOOR AMPHENOL CONNECTOR

Engine compartment closure door wiring harness, carrying circuits to stop, directional, tail, and license lights is connected to apparatus box through an Amphenol connector at rear end of apparatus box near the top.

Refer to symbol on Wiring Diagrams.

Terminal Letter	Circuit	Wire Size & Color
A	No. 1 Engine Comp't. Jct. to Right Side Stop & Directional Light	No. 16 Black
B	No. 21 Engine Comp't. Jct. to Left Side Stop & Directional Light	No. 16 Black
C	No. 6 Engine Comp't. Jct. to License & Taillights	No. 16 Black
D	Ground	Black
E	Spare	Black

SPEEDOMETER AMPHENOL CONNECTORS

Wiring connectors at speedometer drive unit in engine compartment and at speedometer head in gauge panel are made through Amphenol connectors. Symbols on Speedometer Wiring Diagram are the same for both units.

Refer to symbol on Wiring Diagram.

Terminal Letter	Circuit	Wire Size & Color
SPEEDOMETER DRIVE UNIT (IN ENGINE COMP'T.)		
A	To Transmission Amphenol "A"	No. 16 Black
B	To Transmission Amphenol "B"	No. 16 Black
C	To Transmission Amphenol "C"	No. 16 Black
D	To Transmission Amphenol "D"	No. 16 Black
SPEEDOMETER DASH UNIT (IN GAUGE PANEL)		
A	From No. 17 Driver's Control Panel Jct.	No. 16 Nat. - Blk. & Red // Tr.
B	From No. 27 Driver's Control Panel Jct.	No. 16 Grn. - 2 Red // Tr.
C	From No. 37 Driver's Control Panel Jct.	No. 16 Blk. - 2 Brn. // Tr.
D	From No. 7 Driver's Control Panel Jct.	No. 16 Brn. - Nat. & Blk. Cr. Tr.

DIRECTIONAL SIGNAL SWITCH AMPHENOL

Wiring harness connections from the driver's control panel junctions to the directional signal switch are made through an Amphenol connector mounted under the dash panel ahead of the steering column.

Refer to symbol on Wiring Diagram.

Terminal Letter	Circuit	Wire Size & Color
A	To Driver's Control Panel Jct. 41	No. 16 Orange - Grn. Tr.
B	To Driver's Control Panel Jct. 1	No. 16 Nat. - Red Cr. Tr.
C	To Driver's Control Panel Jct. 61	No. 16 Natural
D	To Driver's Control Panel Jct. 11	No. 16 Black - Nat. Tr.
E	To Driver's Control Panel Jct. 21	No. 16 Nat. - Blk. Cr. Tr.
F	To Driver's Control Panel Jct. 51	No. 16 Orange - Blk. Tr.
G	Feed From Driver's Control Panel Jct. 30	No. 16 Nat. - 2 Blk. // Tr.

BATTERY JUNCTIONS

Battery cable junctions are located in three places on the vehicle. Battery cables, carrying current to various parts of the vehicle for operation of the electrical units and systems, are connected at these junctions. Connections must be kept clean and tight. If corroded, disconnect cables and thoroughly clean cable ends and junction studs. Reconnect cables to junction studs and tighten stud nuts firmly. Location of battery cable junctions are as follows:

1. Two junction studs are mounted in top of battery compartment, located on left side of coach at bottom, opposite the exit door stepwell. The junction stud nearest the rear of the coach is the NEGATIVE or GROUND junction. The junction stud nearest the front of the coach is the POSITIVE junction. Battery tray must be pulled out and battery removed for access to junction studs.

2. Driver's control panel battery junction stud is between the junction panel and circuit breaker panel at left of driver (fig. 3).

3. Engine compartment battery junction is located at the bottom of the engine compartment apparatus box (fig. 5).

MISCELLANEOUS CIRCUIT BREAKERS

Heating system water pump motor is protected by a 20-amp automatic reset type circuit breaker connected between the "SOL" terminal of the water pump relay and water pump motor. Circuit breaker, relay, and pump motor are mounted in air duct at rear of left rear wheelhouse on Transit models, or under the seat riser at left rear side on Suburban models. Views of motor, relay, and circuit breaker installed are shown in figures 6 and 7 in "HEATING AND VENTILATION" (SEC. 3) of this manual.

On vehicles equipped with air conditioning, a 90-amp automatic reset type circuit breaker is connected between the blower control relay (magnetic switch) and each under-floor blower motor. Circuit breakers are mounted on regulator and blower control panel (bottom view, fig. 6).

On Suburban models, a 20-amp automatic reset type circuit breaker is connected between the reading lamp relay and each bank of reading lights. Circuit breakers are mounted above the relay on the regulator and blower control panel (bottom view, fig. 6).

TELL-TALE ALARM SYSTEM

TELL-TALE LIGHTS

Ten tell-tale lights are located in gauge and tell-tale panel in front of driver (fig. 1). Tell-tale identification, shown in figure 1, is visible only when the light bulb under the lettering is illuminated. "MASTER" switch on driver's control panel must be in either "DAY" or "NITE" position to energize all tell-tale circuits. Following is a list of all tell-tale lights with a brief description of their purpose and a reference to the Wiring Diagram on which the circuit is shown.

1. "HOT ENG." Tell-tale, interconnected with the alarm buzzer, indicates that the temperature of the engine is too high for safe operation. Engine should be stopped immediately and the overheated condition corrected. Circuit is shown on "Alarm and Signal Wiring Diagram." Refer to "NOTE" following step 2 below.

2. "LOW OIL." This tell-tale, interconnected with the alarm buzzer, indicates that the engine lubricating oil pressure is below 2-3 psi. If tell-tale illuminates and buzzer sounds during operation, stop engine immediately and correct the cause of low oil pressure. Electrical circuit is shown on "Alarm and Signal Wiring Diagram." Refer to "NOTE" below.

NOTE: On vehicles equipped with special automatic engine shut-off system, the "HOT ENG." and "LOW OIL" tell-tale circuits are interconnected with a time-delay safety control relay which automatically shuts off the engine when either one of these abnormal conditions occur. There is, however, a time lag of 20 seconds (plus or minus 3 seconds) after the tell-tale comes on and buzzer sounds before the time-delay relay stops the engine. Operation of Engine Stop Time-Delay Relay System is described later in this section.

3. "LOW AIR." This tell-tale, interconnected with the alarm buzzer, indicates that air pressure is below 60-65 psi. This pressure will not efficiently operate brakes and air suspension system. If tell-tale illuminates and buzzer sounds during operation, stop the vehicle as soon as possible and correct the cause of low air pressure before proceeding. Refer to "Alarm and Signal Wiring Diagram." NOTE: On some coaches equipped with "Wig-Wag" low air pressure warning device, the circuit is disconnected from alarm buzzer (terminal No. 2).

4. "GEN." This tell-tale will light when the "MASTER" switch is placed in "DAY" or "NITE" position and the engine is not running, or when the engine is running and the generator is not charging. If "GEN" tell-tale illuminates during normal operation, the condition should be corrected immediately. Electrical circuit is shown on "Engine Control and Generator Wiring Diagram."

5. "STOP LAMP." This tell-tale illuminates when brakes are applied to indicate normal functioning of stop lights. If tell-tale does not illuminate when brakes are applied, it is an indication that one or both stop-light bulbs are burned out. Refer to "Stop and Directional Light Wiring Diagram."

6. "HI-BEAM." This tell-tale illuminates when headlight high beam is being used. Refer to "Lighting System Wiring Diagram."

7. "DIRECT SIG." This tell-tale flashes on and off when directional signals are being used to indicate normal functioning of signals. If tell-tale fails to illuminate when the directional signal switch is placed in either right or left turn position, it is an indication of a burned out directional signal bulb. Electrical circuits are shown on "Stop and Directional Light Wiring Diagram."

8. "EXIT DOOR." This tell-tale, used on Transit models only, serves to remind the driver that the exit door is unlocked. No attempt should be made to move the coach when this light is on, as the brake interlock system has the rear brakes applied. Refer to "Door Control Wiring Diagram."

9. "EMERG. DOOR." This tell-tale, interconnected with the alarm buzzer, indicates that the emergency exit door is open or partially unlatched. Coach should be stopped and emergency door securely latched for passenger safety. Refer to "Alarm and Signal Wiring Diagram."

10. "A.C. STOP." This tell-tale, used only on coaches equipped with air conditioning, will illuminate when the refrigerant Hi-Lo pressure switch contacts are open, indicating that the compressor drive clutch is disengaged. Refer to "Air Conditioning Wiring Diagram."

11. "TRANSMISSION LOW OIL." This tell-tale, used only on TDM and SDM models, indicates low oil pressure in the mechanical transmission. Electrical circuits and connections are shown on "Mechanical Transmission Wiring Diagram."

ALARM BUZZER AND RECTIFIER ASSEMBLY

Alarm buzzer and rectifier assembly is mounted on junction and apparatus panel at left of driver (item 3, fig. 3). Buzzer and rectifier is interconnected with the "HOT ENG," "LOW OIL," "LOW AIR," and "EMERG. DOOR" tell-tales and their controlling switches, and functions as previously described under "Tell-tale Lights." Refer to "Alarm and Signal Wiring Diagram" for electrical circuits. The rectifier portion of the unit permits current flow in one direction only. Since four different circuits will operate the buzzer, the rectifiers prevent backfeed of current when one abnormal condition exists from illuminating the other tell-tales.

Tell-tale and buzzer circuits can be checked for continuity, referring to the "Alarm and Signal Wiring Diagram." The "MASTER" switch must be in "DAY" or "NITE" position to energize the circuits. When checking hot engine tell-tale circuits, overheat thermostat terminal must be grounded.

Buzzer points can be cleaned, point opening can be adjusted, and the unit can be adjusted to buzz at a specified amperage. Refer to "Specifications" at end of this section.

ALARM SWITCHES

Low oil pressure switch, engine overheat thermostat, and low air pressure switch are covered in other sections of this manual as previously indicated under "Index of Electrical Units."

ENGINE STOP TIME-DELAY RELAY SYSTEM

Air-operated injector shut-off system automatically stops the engine when "MASTER" switch is turned to "OFF" position. Operation and maintenance of this system are covered in "DIESEL ENGINE" (SEC. 8).

The engine stop time-delay relay system is used as special equipment on some coaches. This system is used in conjunction with the low oil pressure and hot engine tell-tale alarm system and the air-operated injector shut-off system to automatically stop the engine when a low oil pressure or hot engine condition occurs. The time-delay relay system comprises the engine stop time-delay relay and three rectifiers. The time delay relay and one rectifier are mounted in the engine compartment apparatus box (fig. 5), and two rectifiers connected into the low oil and hot engine tell-tale circuits, are mounted at forward end of apparatus panel at left of driver (fig. 3). These units are connected into the electrical systems as shown on Engine Control and Generator Wiring Diagram and Alarm and Signal Wiring Diagram. The engine stop time-delay relay, with points normally closed, is fed from the "DAY" and "NITE" positions of the "MASTER" switch. Current for energizing the engine shut-off solenoid valve, which must be energized while engine is running, is fed through the normally-closed points of the time-delay relay. The time-delay relay operating coil is connected to the low oil pressure switch and to the engine overheat thermostat.

When low oil pressure switch or engine overheat thermostat contacts close, circuit is completed through the time-delay relay operating coil. With the relay operating coil energized the relay contacts open, breaking the circuit to the engine shut-off solenoid valve. With solenoid valve de-energized, air pressure is admitted to the engine shut-off air cylinder. The action of the air cylinder on the engine governor moves the injector racks to no-fuel position, stopping the engine.

Action of the time-delay relay is not immediate, as it requires 20 seconds (plus or minus 3 seconds) for the unit to open the contacts. The purpose of the rectifiers in the tell-tale circuits is to prevent backfeed of current from causing tell-tales to function when engine overheat thermostat and low oil pressure switch contacts are open.

NOTE: With engine stopped, low oil pressure switch contacts are closed. When "MASTER" switch is placed in "DAY" or "NITE" position ("DAY" position should always be used for starting engine), circuit through time delay operating coil is completed immediately through the low oil pressure switch. If the engine fails to start during the time required for the time-delay relay contacts to open (20 seconds), the system will act to move the injector racks to no-fuel position (provided air pressure is present in the system). It is then necessary to use the "STOP OVERRULE" switch as explained later.

TIME-DELAY RELAY SYSTEM TEST

Start engine and run for a few minutes to build up air pressure in system. Ground the engine overheat thermostat terminal to complete the circuit through the time-delay relay operating coil and check time lapse before the time-delay relay system acts to stop the engine. Time lapse should be 20 seconds, plus or minus 3 seconds. If engine does not stop within one minute, check operation of engine shut-off solenoid valve and air cylinder before condemning the time-delay relay. Low voltage at relay will also cause slow relay action.

Relay delay time can be adjusted by loosening lock nut and turning adjusting screw. Turn screw clockwise for faster action, or counterclockwise for slower action.

Engine "STOP OVERRULE" Switch

Coaches equipped with automatic engine shut-off system also have an overrule switch, located to rear of emergency stop switch on control panel at left of driver. Overrule switch is a momentary-on type toggle switch; switch must be held up for on position and returns to off position when released. Purpose of switch is to feed current to the engine stop solenoid valve, overruling the engine stop time-delay relay. This permits starting the engine and moving the coach to safety in case the automatic shut-off system shuts off the engine.

RELAYS

Relays are used in some instances to automatically open or close a circuit as operating conditions may require; in other cases they are used to provide a direct connection between the battery and an electrically operated device, with only a small amount of current required to energize the relay operating coil flowing through the controlling switch. The latter use eliminates the use of great lengths of heavy wire, thereby providing higher voltage to the electric device. Several of the same type relays are used on each vehicle; however, they are used in different circuits for different purposes.

Location, operation, and adjustment of various types of relays are described later under individual headings. Before attempting adjustment of relays, make sure points are clean. Clean contact points with a thin, fine-cut file if pitted or burned. Refer to applicable Wiring Diagrams for relay circuits and to identify wires which connect to terminals.

The following tabulation lists each relay used, its location on the vehicle, and its part number. After determining part number of relay, refer to instructions under that part number for operation and adjustment.

Relay	Location	Part No.
*Air Conditioning Control Relay	In Engine Compartment Apparatus Box	1116899
*Blower (Air Cond.)	On Control Panel at Left of Driver	1116852
*Blower Control (Air Cond.)	On Regulator & Blower Control Panel	1119841
Blower Control (2) (Std.)	On Regulator & Blower Control Panel	2351703
Destination Sign (TDH & TDM)	On Control Panel at Left of Driver	1116852
Dome Lamp (TDH & TDM)	On Control Panel at Left of Driver	1116852
Door Control (TDH & TDM)	On Control Panel at Left of Driver	1116852
Engine Modulating (TDH & SDH)	In Engine Compartment Apparatus Box	1116845
*Engine Stop Time Delay	In Engine Compartment Apparatus Box	2395216
Exit Door Switch (TDH & TDM)	In Exit Door Engine Compartment	1116852
Horn	On Control Panel at Left of Driver	1116818
Reading Lamp Relay (SDH & SDM)	On Regulator & Blower Control Panel	2351703
Regulator Sensing Control	On Regulator & Blower Control Panel	1116797
Reverse (TDM & SDM)	In Engine Compartment Apparatus Box	1116852
Starter Control & Generator	In Engine Compartment Apparatus Box	1115822
Stop Light Tell-tale	In Engine Compartment Apparatus Box	1850547
Transmission Control (TDH & SDH)	In Engine Compartment Apparatus Box	1116899
Water Pump, Heating	In Air Duct at Rear of Left Rear Wheelhouse	1116852

*Special Equipment.

RELAY 1115822

Starter control and generator relay is mounted in the engine compartment apparatus box (fig. 5). Electrical circuits are shown on Engine Control and Generator Wiring Diagrams at end of manual, and on Generating System Schematic Wiring Diagram in "GENERATOR" section. This is a two-unit relay which, in conjunction with a resistor in the generator field circuit, automatically opens the starter circuit when the generator is charging.

The smaller of the two units serves as a starter control relay and the actuating current is supplied through the starter switch; this circuit is routed to ground through the generator charging circuit. Battery current is supplied to the lower contact of both relays through terminal number 6. When starter switch is closed and contacts close, battery current flows through the points and number 2 terminal, through number 8 circuit breaker to the starter solenoid, operating the starter. When the engine starts and the starter switch is opened, the operating coil of the starter control relay is de-energized and the points open, breaking the circuit to the starter solenoid.

The operating circuit of the generator relay (large unit) is fed from the "RELAY" terminal on the generator. When generator is charging, operating coil is energized. With the generator relay operating coil energized, the contacts close. Battery current then flows through the contacts and number 5 terminal to engine compartment apparatus box circuit breaker number 8 and junction 42. Junction 42 supplies current to components and circuits that are energized only when generator is charging.

If the starter switch is held closed after the engine starts, as soon as the generator starts charging the current in the charging circuit cancels the current from the starter switch. This causes the starter control relay points to open, breaking the circuit to the starter solenoid.

RELAY ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for closing voltage values.

Air Gap (Fig. 7)

Disconnect battery wire from number 6 terminal, then remove relay cover. Check and adjust each unit as follows:

1. Small Unit. Press armature down until points just close, then measure air gap between armature and center of core. Adjust, if necessary, by bending the lower contact point support.

2. Large Unit. Press armature down until points just close, then measure air gap between armature and center of core. Adjust, if necessary, by loosening two armature hinge bracket attaching screws and moving armature up or down as required. Tighten screws firmly after adjustment.

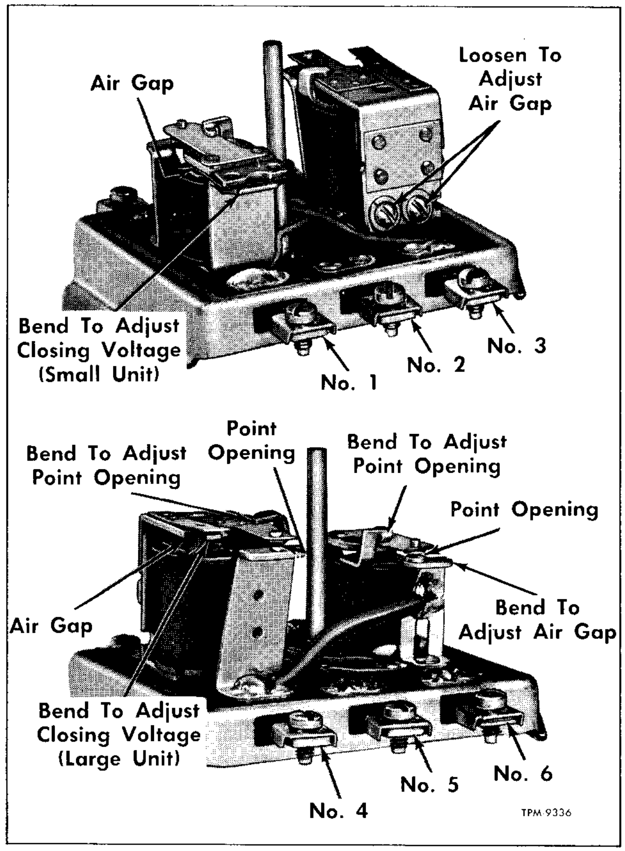


Figure 7—Relay 1115822

Point Opening (Fig. 7)

With battery wire still disconnected from number 6 terminal, check and adjust each unit in same manner as follows:

1. Small Unit. Measure opening between contact points. Adjust, if necessary, by bending armature stop.

2. Large Unit. Measure opening between points with armature up against stop. Adjust, if necessary, by bending the armature stop.

Closing Voltage (Fig. 7)

Check each unit as follows:

1. Small Unit. Battery wire must be disconnected from number 6 terminal so starter will not operate. Connect an accurate reading voltmeter parallel with the relay operating circuit at terminal numbers 1 and 3. Connect a variable resistance unit in series with the operating circuit at number 3 terminal.

While holding engine compartment "START CONTROL" switch in "REAR START" position, slowly decrease resistance until points close and

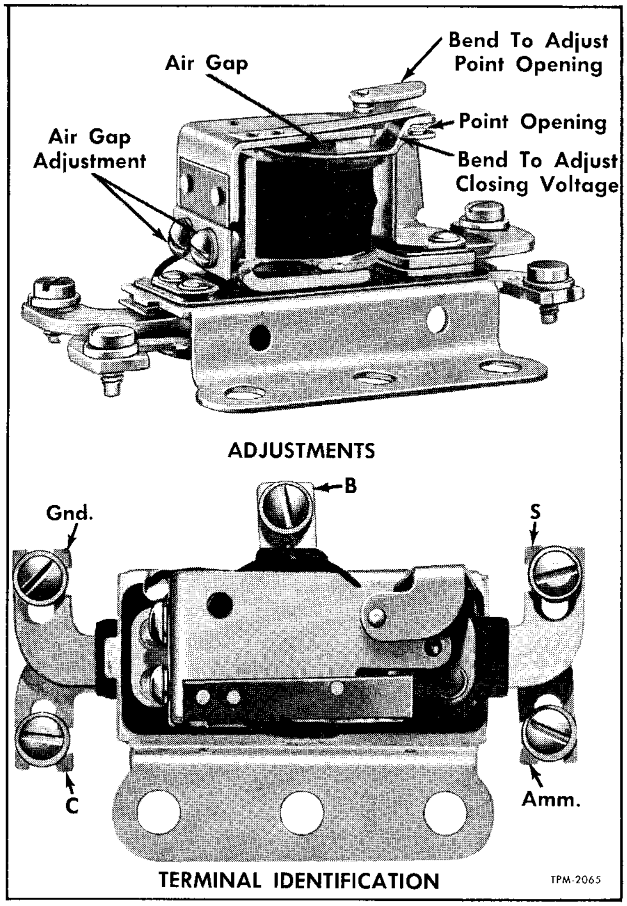


Figure 8—Relay 1116797

note the voltage reading. Adjust, if necessary, by bending the armature hinge bracket to change tension of the spring-type hinge. Increasing spring tension increases the closing voltage; decreasing spring tension lowers the closing voltage.

2. Large Unit. Connect battery wire to number 6 terminal. Connect an accurate reading voltmeter parallel with the relay operating circuit at terminals 1 and 4. Connect a variable resistance unit in series with operating circuit at number 4 terminal. Start engine and run at fast idle. Slowly decrease resistance until points close and note the voltage reading. Adjust, if necessary, by bending the armature spring stop to change tension on spring. Increase spring tension to increase closing voltage; decrease spring tension to lower closing voltage. Remove instruments and make sure wires are all connected and securely tightened after completing adjustment.

RELAY 1116797

Regulator sensing control relay is mounted on the regulator and blower control panel (fig. 6). Electrical circuits and connections are shown on Engine Control and Generator Wiring Diagrams in back of manual, and on Generating System Schematic Wiring Diagram in "GENERATOR" section.

Upper contacts of relay (closed when generator is not charging) are used to carry current for operation of No-Charge tell-tale and excitation current for generator through the regulator. This action takes place when "MASTER" switch is placed in "DAY" or "NITE" position.

When generator is charging, current is supplied from relay terminal of generator through the starter control and generator relay to operating coil of regulator sensing control relay. This action closes the lower contacts and opens the upper contacts, thereby turning off the No-Charge tell-tale light. With lower contacts close, full line current is supplied to "POS" terminal of regulator to provide maximum regulated generator output.

RELAY ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for closing voltage.

Air Gap (Fig. 8)

Remove cover from relay. Press armature down until lower points just close and measure air gap between armature and core. Adjust air gap, if necessary, by loosening two screws and moving armature up or down as necessary. If necessary, bend the lower contact support so the air gap will be uniform across top of core.

Point Opening (Fig. 8)

Measure opening between lower points with upper points closed. Adjust point opening, if necessary, by bending the upper contact support.

Closing Voltage (Fig. 8)

Connect an accurate reading voltmeter parallel with the coil winding from "C" terminal to ground. Connect a variable resistance in series with the coil winding at the "C" terminal. Start engine and run at fast idle (generator charging). Slowly decrease resistance until lower contacts close and note the reading on voltmeter. If not within range listed in "Specifications," adjust by bending the armature spring post to increase or decrease spring tension. Increasing spring tension increases the closing voltage, and decreasing spring tension decreases the closing voltage.

RELAY 1116818

This relay, used only in the horn circuit, is mounted on control panel at left of driver (2, fig. 3). Relay circuits and connections are shown on "Alarm and Signal Wiring Diagram" in back of manual. Coil windings of relay are connected in

series with the horn button. When horn button is pressed, circuit through relay winding is completed and armature is attracted to core. This completes the circuit from the "B" terminal through the closed points and "D" terminal to the horn.

RELAY ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for closing voltage.

Air Gap (Fig. 9)

Disconnect wire from "B" terminal and remove relay cover. Press armature down until points just touch and measure air gap between armature and core. Adjust air gap, if necessary, by loosening two screws and moving armature up or down as required. If necessary, align the support carrying the lower contact so the air gap will be uniform between the coil and the armature.

Point Opening (Fig. 9)

With wire still disconnected from "B" terminal, measure contact point opening with armature up against stop. Adjust opening, if necessary, by bending the armature stop.

Closing Voltage (Fig. 9)

Connect an accurate reading voltmeter parallel with the operating circuit at the "B" and "S" terminals. Connect a variable resistance unit of 10 ohms in series with the operating circuit at the "B" terminal. With horn button pressed, slowly decrease resistance until points close and note the voltmeter reading. Adjust, if necessary, by bending the armature spring post to change tension of armature spring. Increasing spring tension increases the closing voltage, and decreasing spring tension decreases the closing voltage.

RELAY 1116845

This relay, used as an engine modulating relay on TDH and SDH models, is mounted in the engine compartment apparatus box (3, fig. 5). Relay circuits and connections are shown on "Engine Control and Generator Wiring Diagram" for TDH and SDH models, and on "Hydraulic Transmission Wiring Diagram" in back of manual.

Feed circuit from the "MASTER" switch to the engine stop solenoid valve (which must be energized while engine is running) is routed through the normally closed contacts of the engine modulating relay. The relay operating coil is connected to the transmission governor switch through the modulator overrule switch and transmission oil pressure switch. When transmission governor switch closes, calling for shift into direct drive, the modulating

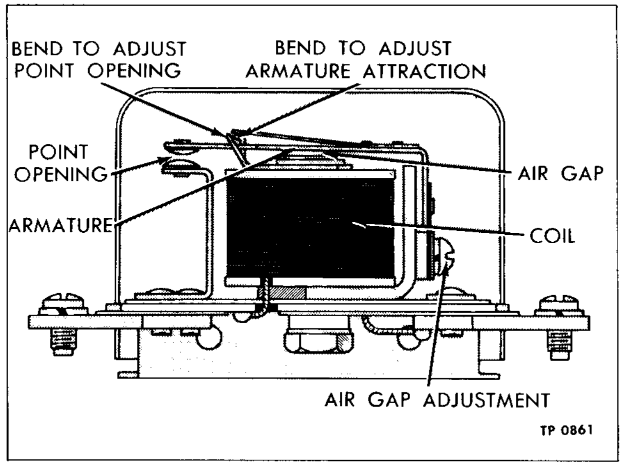


Figure 9—Relay 1116818

relay coil is energized. With coil energized, armature is attracted to core and relay contacts open. This opens the circuit to the engine stop solenoid valve, admitting air pressure to the engine stop air cylinder which moves the injector racks to no-fuel position.

As soon as the transmission shift into direct drive is completed, oil pressure opens the transmission oil pressure switch, breaking the circuit through the modulating relay coil. With coil de-energized the relay contacts close, restoring the circuit through the engine stop solenoid valve. Solenoid valve then exhausts air pressure from the engine stop air cylinder, giving control of the injector racks back to the engine governor.

Although this action, in effect, shuts off the engine, the time lapse between the time the relay coil is energized, the shift is made, and the transmission oil pressure switch breaks the circuit is so short that the engine does not actually stop; this action merely has the effect of forcing the engine speed to reduce while the transmission shift is taking place.

Modulator Overrule Switch

The purpose of the modulator overrule switch, mounted on engine governor, is to prevent engine stall when shift is made into direct drive while coasting with foot off accelerator.

Overrule switch contacts are normally closed, and are open only when governor throttle lever is in idle position. With points open, circuit to modulating relay operating coil is open and the circuit to the engine stop solenoid valve is maintained while accelerator pedal is released, regardless of the action of the transmission oil pressure and governor switches. Refer to FUEL SYSTEM (SEC. 12) for overrule switch installation and adjustment procedure.

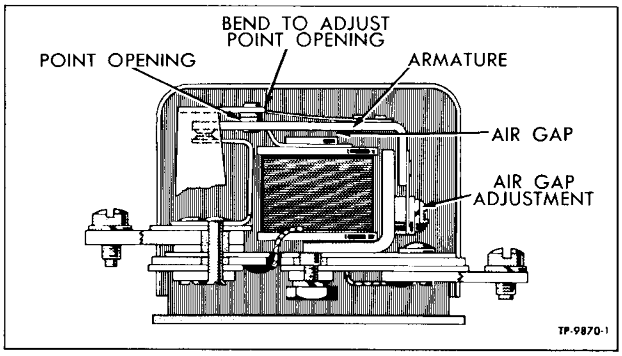


Figure 10—Relay 1116845

RELAY ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for opening and closing voltage.

Air Gap (Fig. 10)

With "MASTER" switch in "OFF" position, remove cover from relay. Depress armature against lower stop and measure air gap between armature and core. Adjust air gap, if necessary, by loosening two screws and moving armature up or down as required. If necessary, bend lower armature stop to obtain uniform air gap between armature and core.

Point Opening (Fig. 10)

Measure point opening with armature depressed against lower stop. Adjust point opening, if necessary, by bending the upper contact point support.

Opening Voltage (Fig. 10)

Connect an accurate reading voltmeter parallel with the operating coil circuit from "S" terminal to ground. Connect a variable resistance unit in series with the operating coil circuit at the "S" terminal. Connect a jumper lead across transmission control relay terminals "4" and "5" to energize the modulating relay operating coil circuit.

Slowly decrease the resistance and note reading on voltmeter when relay contacts open. Slowly increase resistance and note voltage at which points close. If not within limits listed in "Specifications," adjust by bending armature spring stop to change armature spring tension. Increasing spring tension increases opening voltage, and decreasing spring tension decreases opening voltage. After completing adjustment, remove jumper lead from transmission control relay terminals, remove instruments, and reconnect wire to relay "S" terminal.

RELAY 1116852

Several of these relays are used on each vehicle as indicated in the "Relays" tabulation previously. Location and function of each relay are described under individual headings. Adjustment instructions apply to all units. Relay adjustment points are illustrated in figure 9.

DESTINATION SIGN RELAY (TDH & TDM)

Relay is mounted on control panel at left of driver (12, fig. 3). Circuits and connections are shown on "Lighting System Wiring Diagram - TDH & TDM" in back of manual.

Relay "BAT" terminal is fed directly from the control panel battery junction through number 1 circuit breaker. Relay operating coil is energized from the "NITE" position of the "MASTER" switch through number 9 circuit breaker. When "MASTER" switch is turned to "NITE" position, relay coil is energized, armature is attracted to core, and relay points close. Current from the "BAT" terminal then flows through the closed points and "SOL" terminal to the dome lamp relay operating coil through the "OFF" side of the "STANDBY SIGN" switch and the "OFF" side of the "DOME" switch; both of these switches are on recessed switch panel at left of driver. When "STANDBY SIGN" switch is turned on, current from the destination sign relay "SOL" terminal energizes the incandescent standby lights in the destination sign compartment.

DOME LAMP RELAY (TDH & TDM)

Dome lamp relay is mounted on control panel at left of driver (4, fig. 3). Electrical circuits and connections are shown on "Lighting System Wiring Diagram - TDH & TDM" in back of manual.

Relay "BAT" terminal is fed from the control panel battery junction through number 1 circuit breaker. Relay operating coil is energized from the "NITE" position of the "MASTER" switch through the destination sign relay and "OFF" side of "DOME" lamp switch and "STANDBY SIGN" switch on recessed switch panel as explained above. Relay operating coil can also be energized through the on side of the "DOME" lamp switch, regardless of the position of the "MASTER" switch.

When relay coil is energized, points close and battery current flows through the points and "SOL" terminal to the positive (+) terminal of the fluorescent lighting power supply unit. With power supply unit energized, fluorescent lamps in coach ceiling and destination sign compartment are illuminated.

DOOR CONTROL RELAY (TDH & TDM)

Door control relay is mounted on control panel at left of driver (1, fig. 3). Electrical circuits and connections are shown on "Door Control Wiring Diagram" in back of manual.

Relay "BAT" terminal is fed from the "DAY" and "NITE" positions of the "MASTER" switch through number 8 circuit breaker. Relay operating coil is connected to the switch on the air-electric

door control valve. Feed circuit to door control valve switch is energized only when the "DOOR MASTER" switch is in closed position. Relay operating coil is energized when door control lever is in any "rear door unlock" position. When relay coil is energized, points close. Current from "BAT" terminal then flows through points and "SOL" terminal to the exit door solenoid. With solenoid energized, action of solenoid unlocks exit doors, permitting passenger to push doors open.

EXIT DOOR SWITCH RELAY (TDH & TDM)

Exit door switch relay is mounted in exit door engine compartment as shown in figure 2 in "DOORS AND CONTROLS" (SEC. 3). Electrical circuits and connections are shown on "Door Control Wiring Diagram" in back of manual.

Relay "BAT" terminal is fed from the "DAY" and "NITE" positions of "MASTER" switch through number 8 circuit breaker and "DOOR MASTER" switch on recessed switch panel. Relay operating coil is connected to the normally closed (N.C.) terminal of the exit door switch in the door engine compartment. When exit door is unlocked by action of the door control relay and exit door solenoid as explained above, movement of door lock cam lever closes the exit door switch contacts. With exit door switch contacts closed, relay operating coil is energized and points close. Current then flows from the relay "BAT" terminal through the points and "SOL" terminal to the "EXIT DOOR UNLOCKED" lamp above exit door, "EXIT DOOR" tell-tale, and brake interlock magnet valve.

WATER PUMP RELAY

Water pump relay is mounted in air duct at rear of left rear wheelhouse on Transit models, or under the seat riser at left rear side on Suburban models. Views of relay installed are shown in figures 6 and 7 in "HEATING AND VENTILATION" (SEC. 3) of this manual. Electrical circuits and connections are shown on "Heating and Ventilation Wiring Diagram" in back of manual.

Relay "BAT" terminal is fed hot from the battery compartment battery junction through the battery terminal on the blower control relay. Relay operating coil is connected to the "COM" terminal on the heating system modulating valve switch. Relay operating coil is energized whenever "DEFROST" switch is in either "HI" or "LO" position (with "MASTER" switch in "DAY" or "NITE" position), or whenever the thermostat is calling for heat (with generator charging).

When operating coil is energized, relay points close. Current then flows from the relay "BAT" terminal through the points and "SOL" terminal to the heating system water pump motor. Circuit from relay to pump motor is protected by a 20-amp circuit breaker, mounted at side of relay.

AIR CONDITIONING BLOWER RELAY

Blower relay, used on coaches equipped with air conditioning, is mounted on control panel at left of driver (13, fig. 3). Refer to "Air Conditioning Wiring Diagram" in back of manual for electrical circuits and connections.

"BAT" terminal is fed from the charging circuit and is energized only when the generator is charging. Relay operating coil is connected to the "N.C." terminal of the modulating valve switch and is energized only when the thermostat is calling for heat and generator is charging. When operating coil is energized, points close. Current then flows from "BAT" terminal through the points and "SOL" terminal, and to the blower control relay operating coil. The blower control relay then causes the underfloor blower motors to operate at high speed.

REVERSE RELAY (TDM AND SDM)

Reverse relay, used only on coaches equipped with mechanical transmission, is mounted in engine compartment apparatus box (4, fig. 5). Purpose of relay is to complete circuit from battery to reverse solenoid on transmission when "REV" switch (7, fig. 2) is pressed to permit shifting transmission into reverse gear. Relay circuits and connections are shown on "Mechanical Transmission Wiring Diagrams" in back of manual.

Relay "BAT" terminal is fed from battery through number 3 engine compartment circuit breaker. Relay operating coil is connected to "REV" switch on driver's control panel and is fed from number 20 driver's control panel circuit breaker when "MASTER" switch is in "DAY" or "NITE" position. When operating coil circuit is completed at the "REV" switch, relay points close, completing the circuit from battery to reverse solenoid.

RELAY ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for closing values.

Air Gap (Fig. 11)

Disconnect lead from relay "BAT" terminal and remove relay cover. With contact points held closed, measure air gap between armature and center of coil. Adjust air gap, if necessary, by loosening two screws and moving armature up or down as required. If necessary, align the support carrying the lower contact so the air gap will be uniform between the coil and the armature.

Point Opening (Fig. 11)

With lead still disconnected from the "BAT" terminal, measure contact point opening with armature up against stop. Adjust opening, if necessary, by bending the armature stop.

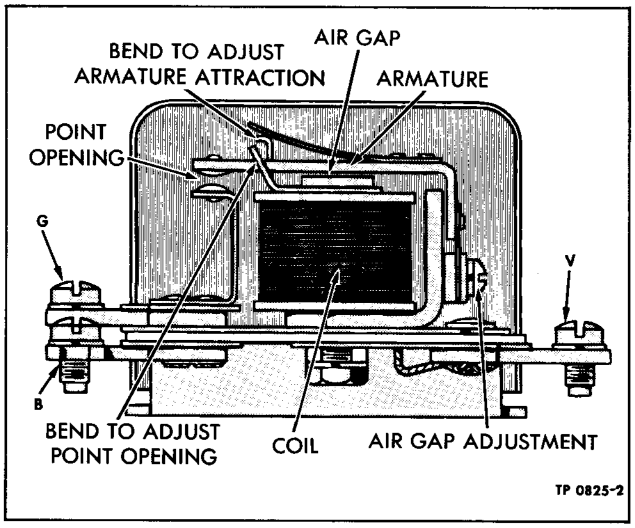


Figure 11—Relay 1116852

Closing Voltage (Fig. 11)

With all leads connected to the relay as shown on the applicable wiring diagram, connect an accurate reading voltmeter in parallel with the relay operating circuit at the "VAC" and "GEN" terminals. Insert a variable resistance unit in series with the operating circuit at the "VAC" terminal. To check closing voltage, close the relay operating switch, then slowly decrease resistance until points close and note the voltage reading. (In some cases, generator must be charging to energize the relay operating circuits.) Adjust, if necessary, by bending armature spring post. Increasing spring tension increases the closing voltage, and decreasing spring tension decreases closing voltage.

RELAY 1116899

Two of these relays may be used, depending upon the coach model and equipment. Location and function of each relay are described under individual headings.

HYDRAULIC TRANSMISSION CONTROL RELAY (TDH & SDH)

This relay, used in the hydraulic drive transmission control system, is mounted in engine compartment apparatus box (9, fig. 5). Electrical circuits and connections are shown on "Hydraulic Transmission Wiring Diagram" in back of manual. Operation and adjustment of relay are covered in "Hydraulic Drive - Model VH" operation and maintenance manual.

AIR CONDITIONING CONTROL RELAY

This relay is used on all models when equipped with air conditioning. Relay is mounted in engine compartment apparatus box (10, fig. 5). Electrical circuits and connections are shown on "Air Conditioning Wiring Diagram" in back of manual, and on "Simplified Schematic Wiring Diagram" in AIR CONDITIONING (SEC. 26). Relay operation and adjustment are described in AIR CONDITIONING (SEC. 26).

RELAY 1119841 (MAGNETIC SWITCH)

This relay (magnetic switch) is used as a blower control relay on coaches equipped with air conditioning. Relay is mounted on regulator and blower control panel (fig. 6). Electrical circuits and connections are shown on "Air Conditioning Wiring Diagram" in back of manual. Relay controls only the blower high speed circuit; low speed circuit is routed directly from the Air Conditioning Control Switch to the blower motors.

Relay battery terminal is fed from the battery junction in battery compartment. Relay operating coil is connected to number 1 terminal on Air Conditioning Control Switch and to "SOL" terminal on blower relay. Operating coil is energized whenever switch is in "BLOWER HI" or "AIR CONDITION" position, or when blower relay points are closed by the action of the modulating valve switch. In either case, the circuit is energized only when the generator is charging. With operating coil energized, relay contacts close, completing circuit to high speed circuit of blower motors.

The relay winding assembly is not removable from the case, however, the contact disc, plunger, and plunger return spring can be removed after removal of the cover. Gaskets on both sides of the moulded terminal ring seal the contact compartment. When assembling, make sure gaskets are in good condition and properly seated.

RELAY 1850547

This relay, used as a stop light tell-tale relay, is mounted in bottom of engine compartment apparatus box (7, fig. 5). Relay electrical circuits and connections are shown on "Stop and Directional Light Wiring Diagrams" in back of manual. Relay is similar in appearance to the horn relay (relay 1116818, fig. 9) and the adjustment points are identical.

Relay is connected into the stop light and stop light switch circuit in such a manner that when brakes are applied and stop light switch contacts close, current to stop lights passes through the relay coil winding. With coil winding energized, armature is attracted to core and relay points close, completing the circuit to the "STOP LAMP" tell-tale in gauge and tell-tale panel, indicating that the stop lights are illuminated.

Stop light tell-tale relay is sensitive to amper-

age, requiring the current draw of both stop light bulbs to close the points. If one bulb is burned out, current draw will not be sufficient to close the relay points, and "STOP LAMP" tell-tale will not illuminate when brakes are applied. When the directional signal lights are being used and brakes are applied, one bulb is intermittently taken out of the circuit to produce the directional signal. To prevent the relay points from opening under these conditions, a resistor, installed on control panel at left of driver (14, fig. 3), is connected into the flasher circuit in such a manner that the resistor is placed into the circuit when the stop light bulb is taken out by the flasher. This provides constant current draw sufficient to keep the relay points closed.

ADJUSTMENTS

Refer to "Specifications" at end of this section for air gap and point opening dimensions and for closing amperage.

Air Gap (Fig. 9)

Remove relay cover. Press armature down until points just close and measure air gap between armature and core. Adjust, if necessary, by loosening two screws and moving armature up or down as required. If necessary, align the support carrying the lower contact so the air gap will be uniform between the coil and the armature.

Point Opening (Fig. 9)

Measure contact point opening with armature up against stop. Adjust opening, if necessary, by bending the armature stop.

Closing Current (Fig. 9)

Connect an accurate ammeter and a variable resistance unit in series with the relay operating circuit at the "S" terminal. Turn "MASTER" switch to "DAY" position. Apply the brakes, or connect a jumper lead across the stop light switch terminals to complete the circuit. Slowly decrease resistance until points close and note reading on ammeter. Increase resistance until the points open and note reading on ammeter. If closing and opening amperage is not within limits listed in "Specifications," adjust by bending armature spring post to increase or decrease spring tension. Increasing spring tension increases closing amperage, and decreasing spring tension decreases closing amperage.

If relay does not function properly during normal operation in vehicle, candlepower of stop light bulbs should be checked. Stop light bulbs of proper size must be used.

RELAY 2351703 (MAGNETIC SWITCH)

Two magnetic switch type relays, controlling circuits to standard heating system blower motors, are mounted on regulator and blower control panel (fig. 6). Electrical circuits and connections are shown on "Heating and Ventilation Wiring Diagram." Relays are fed battery current direct from battery compartment battery junction. Relay operating circuits can be energized only when the generator is charging. With generator charging, relay operating coils can be energized by placing "BLOWER" switch on recessed switch panel in "NORMAL" position; operating coils are automatically energized by the water modulation valve switch whenever the thermostat is calling for heat, regardless of the position of the "BLOWER" switch. When coil windings are energized, the switch contacts close and complete the battery circuit to the blower motor windings.

These are sealed units and are not adjustable or reparable. If either switch fails to function properly, the defective unit must be replaced.

IMPORTANT: When operating blowers from under vehicle by means of a jumper lead to check blower operation or alignment of blower wheels, the following precautions must be observed to avoid burning out the circuit breakers built into the motors.

When connecting jumper lead from "BAT" terminal (large terminal on left side), DO NOT connect to large terminal on right side, to small terminal on left side, or directly to motor terminal. Connect to the small terminal on right side so the current passes through the relay operating coil to the motor; if battery current is fed directly to the motor without passing through the relay operating coil, the motor circuit breakers will burn out. (Right- and left-hand terminals are determined when facing relays as shown in figure 6.)

RELAY 2395216

This is a time-delay relay used in the automatic engine shut-off system. Operation and test of this relay is covered under "Engine Stop Time-Delay Relay System" earlier in this section.

ELECTRIC HORN

Horn (fig. 12) operates on magnetic principle to produce a warning signal. Current from battery flows through windings within horn when circuit is completed by action of a relay when horn button is pressed. Horn circuit is protected by No. 1 circuit breaker on panel at left of driver. Refer to "Alarm and Signal Wiring Diagram" in back of manual for horn circuit.

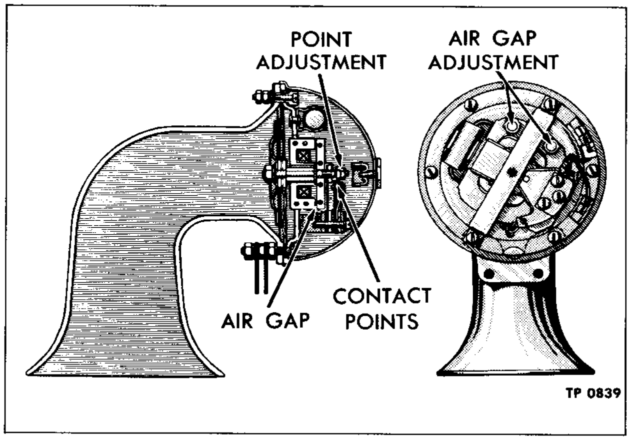


Figure 12—Electric Horn

HORN TESTS

If horn produces a weak signal, voltage at horn should be checked by connecting a voltmeter across horn terminals. The voltage reading should not be less than 11 volts. A lower reading indicates either a low battery or high resistance in horn circuit.

Loose or corroded connections in horn circuit should be corrected. Check for defective wiring by connecting test leads from horn to battery.

A loose connection or poor contact at horn push button may cause horn to operate intermittently. Shunt around the horn button to determine whether there is poor contact at push button. Whenever wiring is replaced in horn circuit, use correct size as shown on wiring diagram.

Horns usually have a rasping sound when vital parts are broken or loose. A loose back shell may affect tone. Tighten collar screws, mounting nuts, and studs. Replace all damaged parts.

The horn will not function properly if field windings within horn are open circuited or grounded. Connect an ammeter in circuit at horn terminal. If there is no indication of current flowing when contact points are closed, windings are open circuited. The ammeter will indicate an excessive flow of current if windings are short circuited or grounded.

Windings may also be checked for grounded circuit with test lamp having its own source of current. Disconnect horn leads and touch one test point to one of the horn terminals and the other point to the horn base. If lamp lights, field windings are grounded.

Excessive arcing at contact points may be caused by improper current adjustment. An open circuit in condenser will cause excessive arcing and, in some cases, contacts will be held together.

HORN ADJUSTMENTS

If tone is not satisfactory after checking preceding conditions, adjust horn in following manner:

1. Remove shell from horn.
2. Connect ammeter in circuit at horn and adjust current consumption by varying position of adjusting nut. Refer to "Specifications" at end of this section for current consumption.
3. Loosen adjusting lock nut and turn adjusting nut to left or right to increase or decrease current.
4. Too much current will cause horn to have a spluttering sound. This adjustment is very sensitive. Move nut 1/10 turn at a time and lock in position each time before trying. If ammeter is not available, adjust according to sound.
5. Correct air gap between armature and core is important for proper tone. The gap must be uniform across entire surface of armature. Width of gap may be determined by using a feeler. Adjustments are made by use of air gap adjusting nuts. Refer to "Specifications" at end of this section for correct adjustment dimensions.

ELECTRIC SPEEDOMETER

The electric speedometer drive unit is mounted in engine compartment, and is driven by a short flexible cable from the transmission speedometer drive gear. A four-wire connector cable plugged into drive unit is connected to an electric motor unit mounted on back of mechanical speedometer head in gauge and tell-tale panel. Electric motor drives speedometer when actuated by electrical impulses from the drive unit. Drive unit uses 12-volt current from the battery. Speedometer circuit is protected by No. 16 circuit breaker on panel at left of driver, and by a 6-amp line fuse installed in the feed line at the drive unit. Refer to "Speedometer Wiring Diagram" in back of manual for electrical circuits.

Current is divided in drive unit by a mechanically driven rotor with two brushes which run against a resistor ring. Varying currents are transmitted to motor on speedometer head through a four wire cable.

Electrical currents from drive unit energize two pairs of coils in motor unit, causing magnetic rotor to rotate at exactly same speed as mechanically driven unit. Since motor is coupled to speedometer head, rotation is transformed to a reading on face of calibrated speedometer head.

TESTING

For testing speedometer electrical units (using battery of 12 volts), plus or minus one volt

variation is permissible. The maximum current consumption should not exceed two amperes.

Jam nut, located at point where four wire conduit fastens to connector plugs, should always be kept tight. The connector plug body grips cable insulation and prevents conduit coming loose from connector plugs due to rough handling which would cause loose connections.

A test light (1568147) should be used to test electric speedometer. If speedometer ceases to function, proceed as follows:

1. Check test light bulbs with battery to be sure they are not burned out.
2. Pull four-contact plug out of top of drive unit and insert plug on end of light cable in its place.
3. Turn "MASTER" switch to "DAY" position to energize drive unit.
4. Disconnect flexible drive shaft at transmission. Turn drive shaft slowly by hand. If lights alternately grow bright and dim, the drive unit is functioning properly.
5. Remove test light cable plug from drive unit and reconnect cable to drive unit.
6. Disconnect cable plug from speedometer head motor and connect to test light cable, using double end male adapter chained to end of cable.
7. Again turn drive shaft slowly by hand. If lights alternately go bright and dim, wiring between drive unit and head is good and trouble should be in head unit.
8. Always be sure that plugs make good contact when connected.
9. If lights fail to check when connected to unit, check feed and ground connections at drive unit for tightness; also for broken drive shaft.
10. If lights check when connected to drive unit but not when connected to front of cable, careful check should be made of electrical cable for broken wire or loose connections where the wires attach to sockets.

With above procedure, it will be easy to determine whether trouble lies in drive unit, in connector plug and wiring, between drive unit and motor unit, or in motor unit and speedometer head assembly.

NOTE: If speedometer test fixture with master head is available, the speedometer can be tested with master speedometer reading 60 miles per hour. If speedometer calibration is not satisfactory when speedometer is driven mechanically, the head may be recalibrated by an authorized United Motors Service Station. Speedometer calibration discrepancies have no connection with the electric drive unit, providing the speedometer head and motor unit are not binding, which is easily discovered by excessive pointer fluctuations.

SPECIFICATIONS

CIRCUIT BREAKERS

DRIVER'S COMP'T. & ENGINE COMP'T. PANELS

Make	FASCO Industries, Inc.
Type	Automatic Reset
Amperage Rating	Refer to Figure 4

READING LIGHT (SUBURBAN MODELS) AND WATER PUMP (HEATING SYSTEM)

Make	FASCO Industries, Inc.
Type	Automatic Reset
Amperage Rating	20 amp.

BLOWER MOTOR (AIR COND.)

Make	Spencer Thermostat Co.
Type	Automatic Reset
Amperage Rating	90 amp.

FUSE

Speedometer Drive Unit Line Fuse	6 amp.

RESISTORS

Stop Lamp	25 watt, 8 ohm
Regulator Sensing Control Relay	100 watt, 3 ohm
Generator Tell-tale	20 watt, 20 ohm

ALARM BUZZER AND RECTIFIER

Make	Delco-Remy
Model	1116981
Point Opening	0.015"
Adjust to Buzz at	0.030-0.035 amps at 13.5-14.5 volts

RELAYS

(Refer to Table on Page 212 for Relay Usage)

1115822

Make	Delco-Remy

Small Unit (Starter Relay)

Air Gap (points closed)	0.011" Min.
Point Opening	0.025"
Closing Voltage Range	8.3-10.2
Opening Voltage	3.2 Max.
Sealing Voltage	10.7 Max.

Large Unit (Generator Relay)

Air Gap (points closed)	0.011"-0.016"
Point Opening	0.023"
Closing Voltage Range	3.3-4.2
Sealing Voltage	0 to 0.9 above closing

SPECIFICATIONS (CONT.)

RELAYS (cont.)

1116797
Make.....Delco-Remy
Air Gap (points closed).....0.012″
Point Opening.....0.020″
Closing Voltage Range.....7.0-9.0

1116818
Make.....Delco-Remy
Air Gap (points closed).....0.022″
Point Opening.....0.030″
Closing Voltage Range.....6.0-8.0
Sealing Voltage.....11.0 Max.

1116845
Make.....Delco-Remy
Air Gap (armature down).....0.012″
Point Operating (armature down).....0.020″
Closing Voltage.....6.0 Min.
Opening Voltage Range.....9.0-10.6

1116852
Make.....Delco-Remy
Air Gap (points closed).....0.022″
Point Opening.....0.030″
Closing Voltage.....7.0 Min.
Sealing Voltage.....9.0 Max.

1116899
Make.....Delco-Remy
Air Gap (points closed).....0.014″
Point Opening.....0.028″
Closing Voltage Range.....8.5-10.5
Opening Voltage.....4.3 Min.

1119841 (Magnetic Switch)
Make.....Delco-Remy
Current Consumption.....1.05-1.17 @ 12 volts

1850547
Make.....Delco-Remy
Model.....268-H
Air Gap (points closed).....0.015″
Point Opening.....0.020″
Closing Current (amps.).....2.35 Max.
Opening Current (amps.).....1.5 Min.

2351703 (Magnetic Switch)
Make.....R-B-M Div., Essex Wire Corp.
Type.....70-111224 Continuous Duty
Voltage.....12

2395216 (Engine Stop Time Delay Relay)
Make.....Eagle Signal Co.
Type.....Single-pole, Double-throw
Voltage.....12
Time Delay (Adjustable)
Factory Setting (except when otherwise specified).....20 seconds, plus or minus 3 sec.

ELECTRIC HORN

Make.....Delco-Remy
Model.....1999700
Voltage.....12
Air Gap.....0.030″-0.034″
Current.....3.5-5.5 amps.
Frequency.....300-320

SPEEDOMETER

DRIVE UNIT
Make.....AC Spark Plug Div.
Model.....1580697

SPEEDOMETER HEAD
Make.....AC Spark Plug Div.
Model.....1587607

Batteries

Battery compartment is located at left side of coach ahead of left rear wheelhouse. To open compartment door, unlock door latch at each upper corner of door, using compartment door key provided, and swing door down. View of batteries installed with compartment door open is shown in figure 1.

Two 12-volt batteries, connected parallel, are clamped in a pull-out tray. Tray is secured in position by a pivot-mounted retainer bolt which engages a slotted bracket at bottom of tray. Battery tray rides in two support channels. A roller is mounted on an eccentric pin and lever assembly in outer end of each support channel. When the levers are pulled out and downward, the eccentric pins cause rollers to rise and support battery tray. An angle stop, bolted to rear of battery tray and extending downward, contacts a stop plate which prevents tray from being accidentally pulled out of support channels.

To pull tray out for servicing batteries, loosen nut on retainer bolt and disengage from bracket. Pull out and downward on roller levers to place tray on rollers, then pull outward. Before pushing tray back into compartment, make sure cable connections are clean and tight, and that batteries are securely clamped in tray. After pushing tray into place, swing roller levers up, engage retainer bolt in slot in retainer bracket, and tighten nut firmly.

IMPORTANT: Observe decal on inside of battery compartment door which reads: CAUTION - NEGATIVE GROUND. It must be emphasized that if the batteries are not connected NEGATIVE GROUND, severe damage to the generator, regulator, batteries, and battery cables will result.

The battery has three major functions to perform on the vehicle.

1. It provides a source of current for starting the engine.
2. It acts as a stabilizer to the voltage in the electrical system.
3. It can for a limited time furnish current when the electrical demands of the electrical equipment exceed the output of the generator.

BATTERY MAINTENANCE

Electrolyte level in the batteries should be checked at least every 1,000 miles or once every two weeks. If the electrolyte level is found to be low, water should be added to each cell until the level rises to the bottom of the vent well. DO NOT OVERFILL! Distilled water or water passed through a "demineralizer" should be used to eliminate the possibility of harmful impurities being added to the electrolyte. Many common impurities will greatly shorten battery life. DO NOT ADD ANY SUBSTANCE TO THE ELECTROLYTE EXCEPT WATER.

The external condition of the batteries and the battery cables should be checked periodically. The top of the batteries should be kept clean and the battery hold-down bolts should be kept properly tightened. For best results when cleaning battery, wash first with a dilute solution of ammonia or soda to neutralize any acid present, then flush off with clean water. Care must be used to keep vent plugs tight so that the neutralizing solution does not enter the cells. The hold-down bolts should be kept tight enough to prevent the batteries from shaking around in their holders, but they should not be tightened sufficiently to place a strain on the battery cases.

To insure good contact, the battery cable clamps should be tight on the battery posts. If the posts or cable clamps are corroded, the cables should be disconnected and the posts and clamps cleaned separately with a soda solution and a wire brush. Install clamps on battery posts and tighten firmly, then coat posts and clamps with petroleum jelly to help retard corrosion.

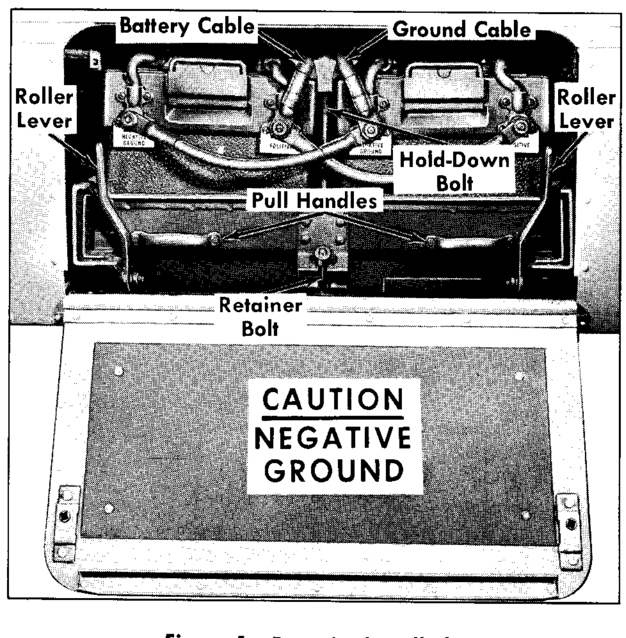


Figure 1—Batteries Installed

BATTERIES

ON VEHICLE TESTS

Three battery checks are described below to determine in a minimum amount of time the condition of the battery.

1. State of Charge (hydrometer test).
2. Battery Capacity Test.
3. Three Minute Battery Test.

If a battery failure is encountered, the cause may lie outside the battery itself. DO NOT BE SATISFIED TO MERELY RECHARGE OR REPLACE IT. FIND THE CAUSE OF FAILURE AND PREVENT RECURRENCE OF TROUBLE.

STATE OF CHARGE (Hydrometer Test)

The hydrometer test is merely a means of determining the state of charge of the battery. This test will not necessarily indicate whether the battery is able to perform its normal functions, such as starting.

1. Measure specific gravity of electrolyte in each battery cell. The hydrometer tube must be held vertically. Do not draw too much electrolyte into the hydrometer. The float must be freely suspended in the electrolyte and the reading taken at eye level. If water has been recently added to the cells, or battery fast charged, the hydrometer reading will be false.
2. Correct hydrometer reading for temperature. When electrolyte temperature is above 80 degrees F., add 4 points (.004) to reading for each 10 degrees above 80. If electrolyte temperature is below 80 degrees F., subtract 4 points for each 10 degrees below 80.
3. Analyze the readings as follows:

a. If the specific gravity readings are 1.215-1.270 at 80 degrees F., and variation between cells is less than 25 gravity points (.025), the battery presumably is at least 3/4 charged and in good condition for further use.

b. If the specific gravity readings are below 1.215 and the variation between cells is less than 25 gravity points, the battery presumably is in sound condition, but its state of charge is too low for further use or testing electrical circuits.

c. If the specific gravity readings show a variation between cells of more than 25 gravity points, an unsatisfactory battery condition is indicated which may be caused by shorted cells, acid loss, or a worn out battery.

To determine whether a battery is a good battery, regardless of its state of charge, proceed with the "Battery Capacity Test" below:

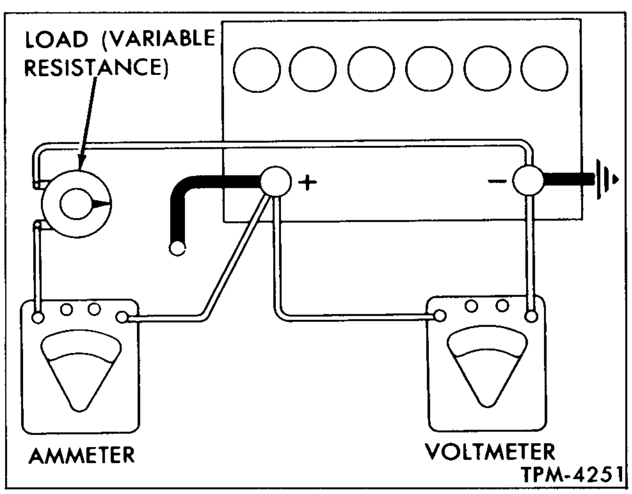


Figure 2—Typical Test Hook-Up For Battery Capacity Test

BATTERY CAPACITY TEST

This test is one means of determining whether a battery is functioning efficiently to the degree where it can be relied upon to perform all of its duties properly in the vehicle.

A 12-volt battery that will maintain 9.0 volts or better during a battery capacity test should be considered a good battery. To make this test, use equipment that will take a heavy electrical load to the battery such as a carbon pile or other suitable means. If test equipment is not available for loading battery, the starter may be used as a load.

1. Connect positive voltmeter and ammeter leads to battery positive post, and connect negative voltmeter and ammeter leads to battery negative post (fig. 2). NOTE: Ammeter cable clips must contact battery posts; voltmeter cable clips must contact battery post or cable clamp, not the ammeter cable clips.
2. Apply a load to the battery of three times the ampere-hour rating of the battery for 15 seconds. Refer to "Specifications" at end of this section for ampere-hour rating of battery used in vehicles covered by this manual.
3. With ammeter reading specified load, read voltage which should not be less than 9.0 volts.

a. If voltmeter shows 9.0 volts or more, battery has good output capacity and will readily accept a normal charge.

(1) If specific gravity is 1.215 or more, no service is required.

(2) If specific gravity is below 1.215, check charging circuit to determine the cause and correct as required. The battery should be slow-charged for city driving. With highway driving and a good charging system, the battery should charge satisfactorily.

b. If voltmeter shows less than 9.0 volts, proceed with the "Three-Minute Battery Test" described following:

THREE-MINUTE BATTERY TEST

In cases where a voltage of less than 9.0 volts is obtained in the "Battery Capacity Test" described above, an accurate test using a voltmeter and a fast charger will quickly establish in three to four minutes whether a battery is good or bad even when the battery is in a discharged condition.

This procedure determines the condition of charged or discharged batteries by following the principles that:

a. A charged battery may be tested by taking current out of it.

b. A discharged battery may be tested by passing current through it.

THIS TEST SHOULD NOT BE USED IF BATTERY TEMPERATURE IS BELOW 60 DEGREES F.

If battery temperature is above 60 degrees F., add battery water, if necessary, and proceed with the three-minute battery test. CAUTION: Do not make this test, which is recommended for discharged batteries, if voltage obtained in "Battery Capacity Test" is 9.0 or more. A charged battery will not accept 40 amperes without an excessively high voltage.

Test Procedure

If voltage obtained in "Battery Capacity Test" was less than 9.0 volts, fast charge battery at 40 amperes for 3 minutes. Then, with charger still operating, test individual cell voltages of battery.

NOTE: Since cell connectors are not exposed, it is necessary to pierce the cover to contact the connector straps to obtain individual cell voltages. Where pierced, the connectors should be resealed. A hot soldering iron may be used to reseal the connectors. DO NOT USE AN OPEN FLAME NEAR THE BATTERY.

a. If cell voltages are uneven by more than 0.1 volt, replace the battery.

b. If cell voltages are even within 0.1 volt, test total battery voltage with charger still operating on fast charge.

(1) If total voltage is over 15.5 volts, battery is unsatisfactory and is probably sulfated. Battery may be serviceable after continued slow charge, then test capacity. If above 9.0 volts, place back in service. If below 9.0 volts, replace the battery.

(2) If total voltage is under 15.5 volts, test specific gravity and charge battery.

OFF VEHICLE SERVICE

COMMON CAUSES OF BATTERY FAILURE

When a battery fails, the cause of failure may lie outside the battery itself. For this reason, when a battery failure is encountered, do not be satisfied to merely recharge or replace it. Find the cause of the failure and prevent recurrence of the trouble. Listed below are some of the common causes of battery failure.

1. Defect in generating system such as high resistance or faulty generator or regulator.

2. Overloads caused by defective starter or excessive use of accessories.

3. Dirt and electrolyte on top of battery causing a constant drain.

4. Hardened battery plates, commonly called "sulfation," due to battery being in a low state of charge over a long period of time.

5. Physical defects such as shorted cells, loss of active material from plates, etc.

6. Driving conditions or requirements under which the vehicle is used only for short drives.

CHARGING

Batteries removed from the vehicle for charging should be charged continuously at a low rate until fully charged. Batteries may be safely slow-charged at a rate in amperes equal to 7% of the battery's ampere-hour capacity. (Refer to "Specifications" at end of this section for ampere-hour rating of battery used.) This is called the "normal" charge rate. The battery is fully charged when specific gravity readings taken at hourly intervals show no increase during three consecutive readings.

A very low rate -- not more than one-half the normal charging rate -- should be used for charging a sulfated battery. In the case of badly sulfated batteries, as much as 100 hours of charging time may be required before the battery becomes fully charged. Badly sulfated batteries may require a continuous slow charge for 48 hours or more before a rise in gravity reading occurs. If the specific gravity reading of any cell fails to reach 1.250 (corrected to 80°F.) or if there is a variation of more than 25 gravity points between cells after thorough slow charging, replace the battery.

Although the slow-charge method is recommended for charging all batteries, discharged batteries in otherwise good condition (refer to "Battery Capacity Test") may be given a boost with a quick charger if time does not permit complete slow charging. When using a quick charger, it must be remembered that the battery is only receiving a partial charge and that the battery electrolyte temperature must not be allowed to exceed 130°F. If the battery heats up excessively, quick charging must be discontinued.

BATTERY CABLES

Check all cable leads and connections to determine if they are in good condition. Excessive resistance, generally caused by poor connections, produces abnormal voltage drop which may lower voltage at starting motor to such a low value that

normal operation of starting motor will not be obtained. Abnormal voltage drop can be detected with a low-reading voltmeter as follows:

NOTE: To prevent engine starting while operating starter, block stop lever on top of engine governor in no-fuel position. Place engine compartment control panel "ENGINE CONTROL" switch in "REAR RUN" position to energize the starter control circuit just before making each check. On vehicles equipped with automatic engine shut-off system, the engine stop time delay relay will open the starter circuit 20 seconds after the control switch is turned on. If this occurs, turn "ENGINE CONTROL" switch to "OFF" position to permit the engine stop time delay relay to re-set.

1. Check voltage drop between grounded (negative) battery terminal and vehicle frame. Place one prod of voltmeter on battery terminal and other on vehicle frame. With starting motor cranking engine at normal room temperature (70°F.), voltage reading should be less than 0.3 volt. If more than this, there is excessive resistance in this circuit.

2. Check voltage drop between ungrounded (positive) battery terminal and starting motor terminal stud while motor is operated. If reading is more than 2.5 volts, there is excessive resistance in circuit. NOTE: If necessary to extend wire from the meter for this test, use No. 16 or larger wire.

3. Check voltage drop between starting motor housing and vehicle frame. This must be less than 0.2 volt.

SPECIFICATIONS

Manufacturer	The Electric Storage Battery Co.
Quantity	2, Connected Parallel
Type	
With 6V-71 Engine	Ultra-Start LX-B4
With 8V-71 Engine	Hycap 8D
Plates Per Cell	
With 6V-71 Engine	17
With 8V-71 Engine	25
Amp. Hour Capacity @ 20 Hour Rate (Each Battery)	
With 6V-71 Engine	175
With 8V-71 Engine	200

Starting System

GENERAL

The starting system includes batteries, starter, starter solenoid, starter relay (incorporated in starter control and generator relay), starter switches, circuit breakers, and interconnecting wiring and cables. Starting system control circuits are shown on "Engine Control and Generator Diagrams" in back of manual. Refer to "Relays" in "WIRING AND MISCELLANEOUS ELECTRICAL" section for information on all relays.

CONTROL SYSTEM OPERATION

Starter control system is inoperative with "START CONTROL" and "ENGINE CONTROL" switches on engine compartment control panel in "OFF" position; these switches must be in "NORMAL" position to operate starter from driver's compartment. On models with hydraulic transmissions, transmission shift lever must be in neutral to operate starter from either control panel.

The "MASTER" switch must be in "DAY" position (when starting at front) or engine compartment control panel "ENGINE CONTROL" switch (fig. 1) must be in "REAR RUN" position (when starting at rear) to energize the engine stop solenoid valve and to complete the circuit to starter switch. When starter switch is closed, circuit is completed through operating coil of starter relay portion of starter and generator control relay, causing the contacts of the relay to close. Battery current then flows from number 6 terminal through the closed contacts of the starter relay to the operating coil of the starter solenoid. With solenoid operating coil energized, circuit is completed direct from battery to starter.

On coaches equipped with automatic engine shut-off system, circuit from "MASTER" or "ENGINE CONTROL" switch to engine stop solenoid valve is routed through the normally closed contacts of the engine stop time delay relay. If engine fails to start within 20 seconds after circuit is energized, the time delay relay contacts will open; "MASTER" or "ENGINE CONTROL" switch must then be momentarily returned to "OFF" position to permit the time-delay relay to reset itself and close the contacts.

On coaches equipped with parking lot heater connections, circuit to starter relay operating coil is routed through the "STARTER CUT-OUT" switch, located in radiator filler door (fig. 2). This switch must be in "NORMAL" position for starter to operate.

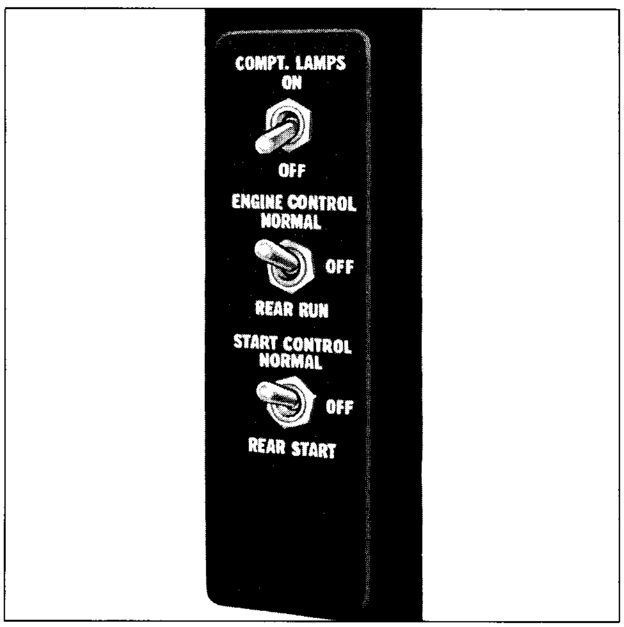


Figure 1—Engine Compartment Control Panel

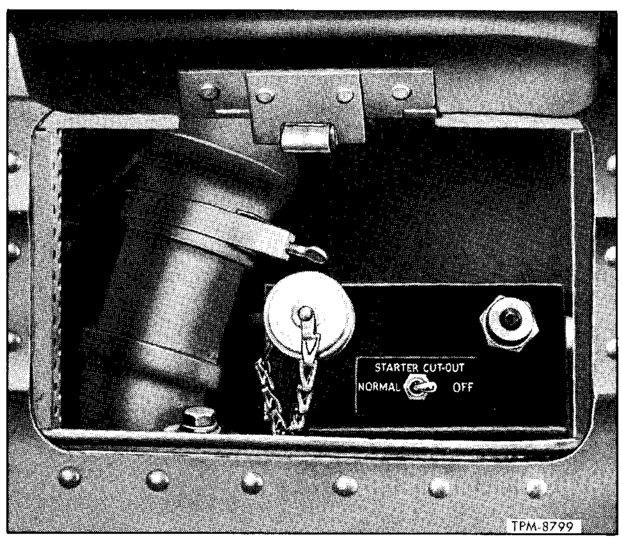


Figure 2—Starter Cut-out Switch (Special Equipment)

STARTER

DESCRIPTION

Starter (fig. 6) is a heavy duty unit, solenoid operated through an enclosed shift lever. Starter is equipped with a heavy duty sprag type overrunning clutch. A removable plug is provided in shift lever housing to permit adjustment of pinion clearance.

Armature shaft is supported in bronze bushings at three points -- in commutator end frame, in shift lever housing, and in nose housing. Positive lubrication is provided at each bushing by an oil saturated wick that projects through the bushing and contacts the armature shaft. A waste-filled oil reservoir for each wick provides a large oil supply.

O-ring seals are used between commutator end frame and field frame, and between shift lever housing and field frame. A spring-loaded lip type oil seal together with an O-ring seal in shift lever housing and a boot over the solenoid plunger prevents entry of transmission oil into the armature, field coils, and solenoid case.

Two brushes are carried in each of four holders mounted on plates which are attached to, but insulated from the commutator end frame. As shown on internal wiring diagram (fig. 3), two sets of brushes are connected to the ground terminal stud on commutator end frame; these connections are made through the brush holder mounting plate. The other two sets of brushes, which are insulated from mounting plate, connect to field coil leads.

STARTER DRIVE OPERATION

When starter circuit is energized, shift lever operated by solenoid slides the pinion into mesh with flywheel ring gear teeth. The rotary motion between pinion and ring gear, provided by the spiral splines on clutch shaft, normally relieves tooth abutment on the first attempt. A protective sleeve located on spiral spline acts as a stop for the pinion when extreme tooth abutment occurs. This limits the clutch travel, preventing the switch contacts in solenoid from closing. Therefore, armature cannot rotate before pinion is engaged properly, preventing damage to pinion and ring gear. A second attempt to engage rotates pinion enough to assure proper engagement.

MAINTENANCE

Other than periodic lubrication as directed in LUBRICATION (SEC. 13) and keeping cable connections clean and tight, the starter should require no periodic maintenance. The brushes can be inspected and replaced without disassembling the starting motor; however, it must be removed from the engine. Starter is accessible through access opening in crossmember underneath the vehicle.

BRUSH REMOVAL

1. Remove starting motor from engine.
2. Loosen two screws holding cover band on commutator end of field frame, then remove cover band.
3. Remove screws and washers attaching brush leads and field coil leads to brush holders.
4. Using a screwdriver as shown in figure 4, bend brush holder spring back and remove brush from holder.

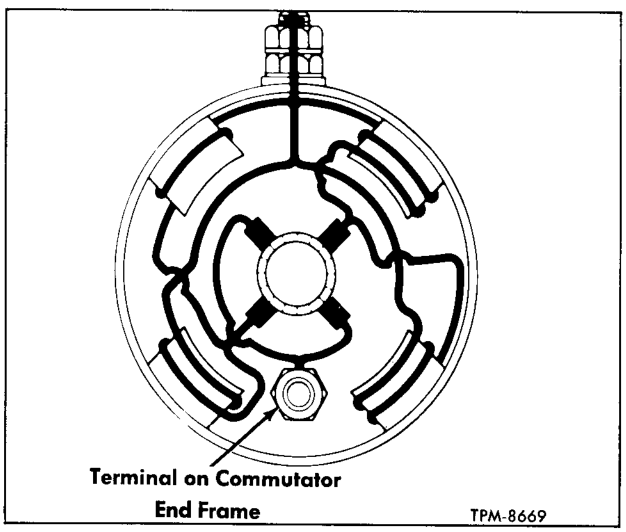


Figure 3—Starter Internal Wiring Diagram

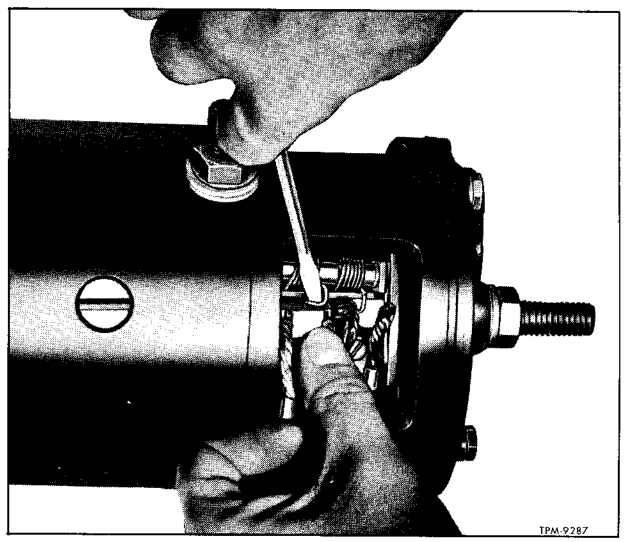


Figure 4—Removing or Installing Brushes

BRUSH INSPECTION

1. When brushes are worn down to less than one-half their original length, they must be replaced (original length is 3/4").

2. Be sure leads are secure in brushes and that clips are properly soldered to leads.

BRUSH INSTALLATION

1. Using screwdriver to bend brush holder spring as shown in figure 4, and with groove in brush aligned with ridge in holder, insert brushes in holders.

2. Position brush leads and field coil leads to brush holders and attach with one screw and washer in each brush. Tighten screws firmly.

3. Position cover band over commutator end of field frame, and tighten cover band screws firmly.

4. Install starting motor on engine.

STARTER FREE SPEED CHECK

Before disassembling starter, the following check of starter operation can be made to determine conditions which may require special attention during overhaul.

To make this check, connect an ammeter in series with the positive (+) terminal of a 12-volt battery and the "BAT" terminal of the starter solenoid (fig. 5). For the return circuit, connect a lead from the starter frame to the battery negative (-) terminal. Connect a voltmeter from solenoid "BAT" terminal to ground on starter frame.

Use a tachometer at end of armature shaft (fig. 5) to determine armature rpm. Energize the solenoid by connecting a jumper lead from the solenoid "BAT" terminal to the solenoid switch terminal. Observe the armature rpm, voltage, and current draw. Failure of starter to operate according to values listed in "Specifications" at end of this section may be due to tight or dry bearings, or to high resistance connections.

STARTER DISASSEMBLY

(Refer to Figure 6)

1. Using a prick punch or small chisel, mark relative positions of commutator end frame and shift lever housing to field frame, and position of nose housing to shift lever housing so they can be reassembled in same positions.

2. Remove nut and lock washer attaching solenoid "MOTOR" terminal connector strap to terminal stud on field frame. Also disconnect solenoid ground lead from terminal stud on commutator end frame.

3. Remove plug and gasket from shift lever housing. Remove nut from end of solenoid plunger rod, then remove solenoid assembly from field frame and shift lever housing.

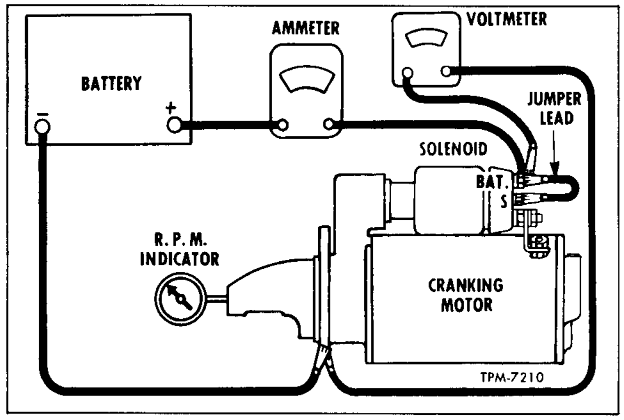


Figure 5—Test Hook-up For Checking Starter Free-Speed

4. Remove six socket-head screws attaching nose housing to shift lever housing. Remove nose housing from lever housing and armature shaft.

5. Remove cover band assembly from commutator and field frame assembly. Disconnect field coil leads from brush holders.

6. Remove bolts and lock washers attaching commutator end frame to field frame. Remove commutator end frame assembly from field frame and armature shaft. Remove thrust washer from armature shaft.

7. Remove bolts and lock washers attaching shift lever housing to field frame. Separate field frame from shift lever housing and remove field frame from armature.

8. Withdraw armature from shift lever housing, removing drive clutch assembly from armature shaft as armature is removed. Remove brake washer from armature shaft, and remove collar and O-ring from counterbore in shift lever housing.

9. It is not necessary to further disassemble starter unless parts require replacement as directed later under "Inspection, Tests, and Repair."

INSPECTION, TESTS, AND REPAIR

(Refer to Figure 6)

The overrunning clutch assembly, armature, and field frame and coil assembly should not be cleaned in a degreasing tank or with grease dissolving solvents, since these would dissolve the lubricant in the clutch mechanism and damage the insulation in the armature and field coils. All parts except the clutch should be cleaned with oleum spirits and a brush. The clutch should be wiped with a clean cloth. Commutator can be cleaned with No. 00 sandpaper. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR.

ARMATURE

If the armature commutator is worn, dirty, out-of-round, or has high insulation, the armature

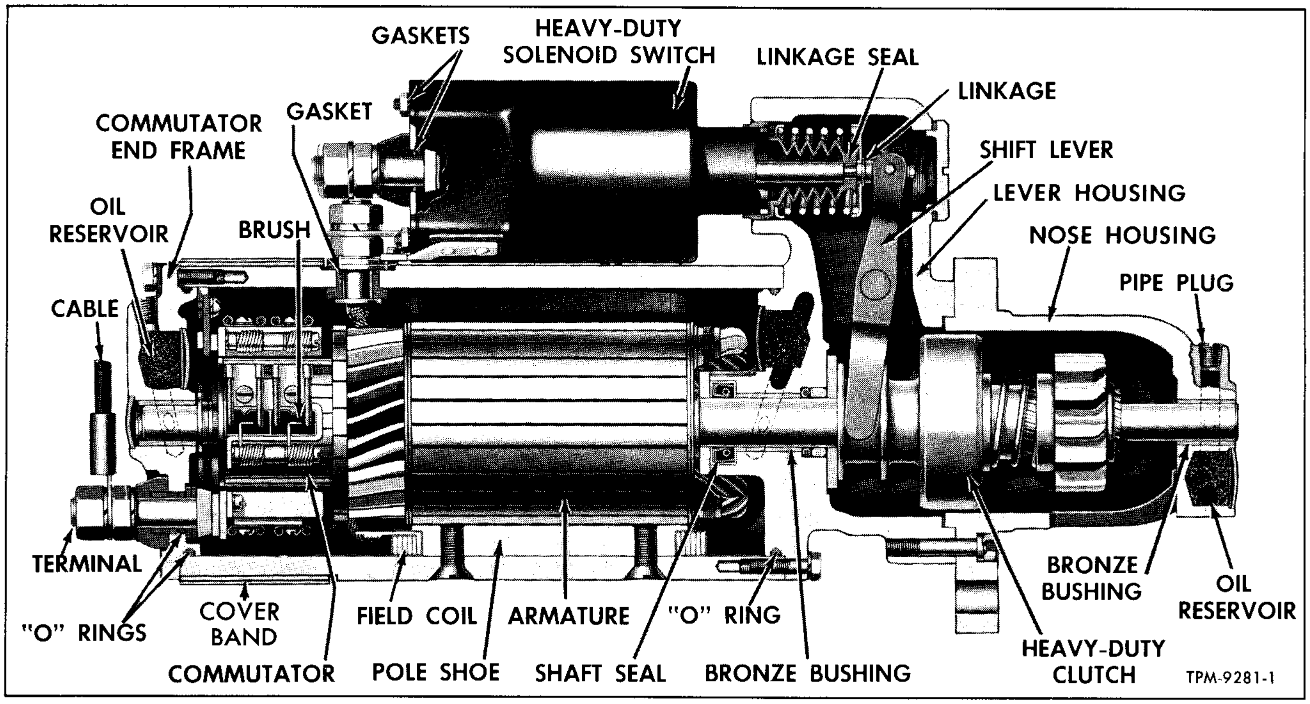


Figure 6—Starter and Solenoid Assembly

should be placed in a lathe and the commutator turned down. Do not cut deeper than necessary to remove rough spots or out-of-round condition. DO NOT UNDERCUT THE INSULATION BETWEEN THE COMMUTATOR SEGMENTS AFTER TURNING DOWN THE COMMUTATOR AS HAS BEEN THE PRACTICE IN THE PAST.

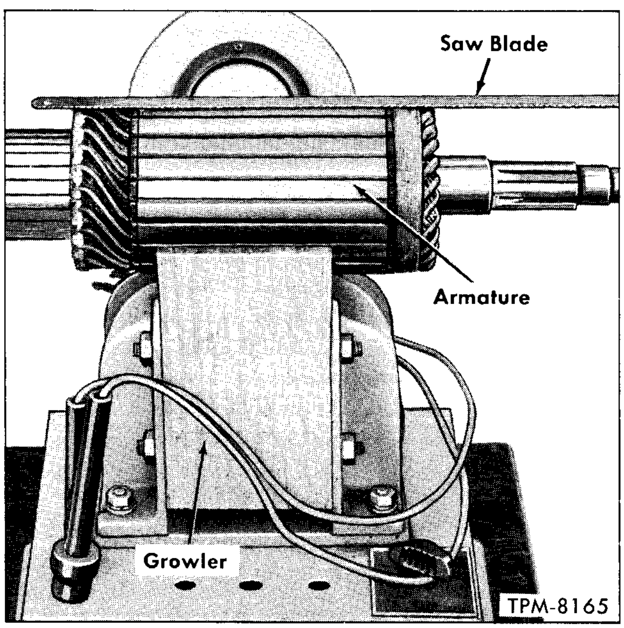


Figure 7—Checking Armature For Short Circuits

The armature should be checked for open circuit, short circuit, and grounds as follows:

Open Circuit Test

Open circuits are usually caused by excessively long cranking periods. The most likely place for an open circuit to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of commutator bars. If bars are not too badly burned, repairs can sometimes be made by resoldering the leads in the riser bars, using rosin flux solder. After soldering, turn down commutator and undercut the insulation.

Short Circuit Test

Short circuits in the armature are located by the use of a growler. When armature is rotated in the growler with a still strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuits is located (fig. 7). Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots.

Ground Test

Grounds in the armature can be detected with a 110-volt test lamp and test points. If the lamp

lights with one test point on commutator and the other on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure, which is often brought about by overheating due to excessively long cranking periods, or by accumulation of brush dust between the commutator bars and the steel commutator ring.

FIELD COILS

Internal wiring circuits are shown in figure 3. Connect one test lamp lead to the field frame and the other to the terminal stud on the field frame. If lamp lights, at least one of the field coils is grounded and it must be repaired or replaced.

Connect one test lamp lead to the terminal stud on field frame and the other, in turn, to each of the field coil leads which connect to the brush holders; lamp should light. If lamp fails to light in either case, the field coils are open.

Field Coil Replacement

Field coils can be removed from the field frame by using a pole shoe screwdriver. A pole shoe spreader should also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding the field coils as the pole shoes are tightened into place. Each pole shoe has a long lip on one side and short lip on the other; they should be installed with the long lip pointing in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

COMMUTATOR END FRAME

Remove all brushes. Place one test lamp lead on end frame, and the other, in turn, on each of the brush holders and on terminal stud. If lamp lights it is an indication of defective brush holder insulation or terminal insulators. Replace defective insulators under brush holder mounting plates or at terminal stud.

If brushes are worn down to less than one-half their original length, they must be replaced (original length is 3/4"). Be sure leads are secure in brushes and that clips are properly soldered to leads.

Check brush spring tension. If not within limits listed in "Specifications" at end of this section, replace with new springs. Examine brush holders and hinge pins for bent or damaged condition. Any condition which might prohibit free brush action must be corrected.

Examine bushing in end frame for excessive wear or out-of-round condition. Original diameter of bushing is listed in "Specifications" at end of this section. Replace bushing, if necessary, as directed following.

Bushing Replacement

1. Remove expansion plug from armature shaft bore.
2. Remove expansion plug from oil reservoir and remove pipe plug from oil wick passage. Remove packing and oil wick from reservoir.
3. Press old bushing from end frame and press new bushing into place.
4. Using a drill same size as oil wick passage, run drill through passage to cut through edge of bushing. Remove burrs from bushing caused by drilling operation.
5. Install new oil wick and fill oil reservoir with fine wool packing material. Saturate reservoir packing and oil wick with engine oil, then install new expansion plug with gasket in oil reservoir opening.
6. Install new expansion plug with gasket in armature shaft bore in end frame.

SHIFT LEVER HOUSING

Inspect oil seal and bushing in shift lever housing for evidence of damage or excessive wear. Original diameter of bushing is listed in "Specifications" at end of this section. Replace bushing, if necessary, as directed in "Bushing Replacement" under "Commutator End Frame," omitting steps 1 and 6. When installing new oil seal, lip must point inward.

If shift lever appears excessively loose on lever shaft, worn parts can be replaced by removing retaining ring from exposed small end of lever shaft, then driving shaft out of housing. When installing lever and shaft, use new O-rings in grooves in shaft.

NOSE HOUSING

Inspect bushing in nose housing for wear, referring to "Specifications" for original bushing diameter. Replace bushing, if necessary, as directed in "Bushing Replacement" under "Commutator End Frame," omitting steps 1 and 6.

OVERRUNNING CLUTCH ASSEMBLY

Drive pinion must rotate freely in overrunning direction and must not slip in cranking direction. If drive pinion turns roughly or slips, replace the complete drive clutch assembly.

STARTER ASSEMBLY

(Refer to Figure 6)

1. Lubricate splines of armature shaft with engine oil, then insert drive end of armature shaft through shift lever housing until shaft just extends through housing. Place O-ring and collar over armature shaft and position in counterbore in housing. Place brake washer over end of shaft.
2. Position drive clutch assembly in lever

Figure 8—Installing Commutator End Frame

housing with lugs on lever yoke engaging groove in drive clutch shift collar, then push armature shaft through housing and drive clutch.

3. Place gasket in counterbore in shift lever housing, then install nose housing over armature shaft and position at lever housing, with marks made prior to disassembly aligned. Attach nose housing to lever housing with six socket head screws; tighten screws to 13-17 foot-pounds torque.

4. Install new O-ring in groove in field frame side of shift lever housing. Install field frame over armature and position against shift lever housing, with marks made prior to disassembly aligned. Attach lever housing to field frame with five cap screws and lock washers. Tighten cap screws firmly.

5. Position solenoid with plunger assembly on field frame, inserting plunger rod end of solenoid into shift lever housing. Through opening in opposite side of lever housing, make sure plunger rod passes through plunger rod guide in shift lever. Thread adjusting nut a few turns onto plunger rod. Attach solenoid to field frame with four cap screws and lock washers. Install connector strap on solenoid "MOTOR" terminal and field frame terminal stud.

6. Place thrust washer over commutator end of armature shaft. Place new O-ring in groove around commutator end frame. With marks made prior to disassembly aligned, install end frame to field frame as shown in figure 8. Attach end frame to field frame with four cap screws and lock washers; tighten firmly. Through openings in field frame, install brushes and connect field coil leads to brush holders as previously directed in "Brush Installation" under "Maintenance."

7. Install cover band over commutator end of field frame and tighten two screws firmly. Connect solenoid ground lead to terminal stud on commutator end frame.

8. Adjust pinion clearance as directed below.

PINION CLEARANCE ADJUSTMENT

1. To check the pinion clearance, connect a 6-volt battery from solenoid switch terminal to starter frame (fig. 9). If solenoid does not operate, use a 12-volt battery. To prevent starter from motoring, connect a heavy jumper from solenoid "MOTOR" terminal to starter frame (fig. 9).

2. With solenoid energized and drive clutch shifted toward the nose housing, push the pinion back toward armature to take up slack, then check clearance between the pinion and nose housing (fig. 10). Adjust nut on solenoid plunger rod as necessary to obtain the proper clearance of 23/64 inch. After correct adjustment is obtained, install access plug and gasket in shift lever housing.

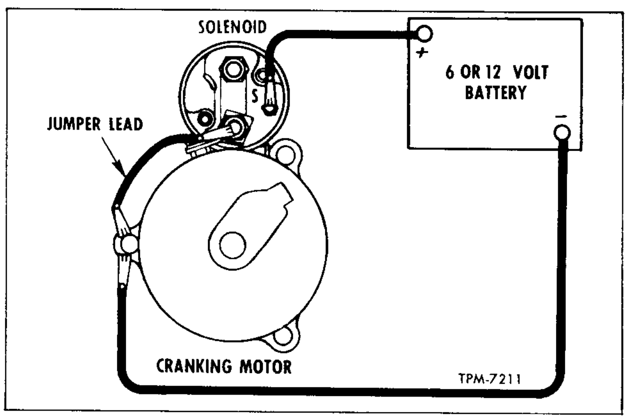


Figure 9—Test Hook-up For Checking Pinion Clearance

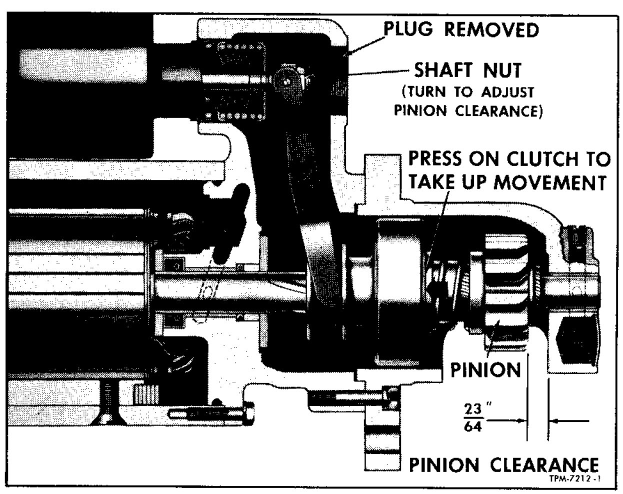


Figure 10—Pinion Clearance Check and Adjustment

STARTER SOLENOID

Starter solenoid is used to shift the starter drive pinion into engagement with flywheel teeth and to complete the circuit from battery to starter.

Solenoid has two windings, the pull-in winding and the hold-in winding. When starter switch is closed, both windings are energized, producing a magnetic field which pulls the plunger in. Inward movement of plunger shifts starter pinion into engagement with flywheel ring gear teeth, and closes the main contacts in the solenoid switch to complete the circuit from battery to starter.

The pull-in winding draws comparatively heavy current for a short interval. This is required to shift the pinion into engagement. The hold-in winding also aids the pull-in winding. As soon as plunger closes the main switch contacts, pull-in winding is de-energized and only the hold-in winding draws current for the balance of the starting cycle.

SOLENOID MAINTENANCE

Solenoid requires no periodic maintenance other than keeping the terminals clean and tight. Always check action of solenoid if it has been removed. If unit fails to function, first check wiring before condemning the solenoid. Solenoid windings can be checked for current draw, open circuit, or shorts. Refer to "Specifications" at end of this section for current values. Solenoid coil, terminals, and switch plunger can be replaced if burned or otherwise damaged. Whenever solenoid is replaced, pinion clearance must be checked and adjusted, if necessary, as previously directed in starter assembly procedures.

Refer to next page for Specifications.

SPECIFICATIONS

Make	Delco-Remy
Starter Model	1114100
Rotation (Viewing Drive End)	Counterclockwise
Minimum Brush Spring Tension	35 oz.
No-Load Test	
Volts	11
Maximum Amps.	170
Minimum Rpm	6300
Lock Test	
Volts	1.5
Maximum Amps.	700
Minimum Torque (Ft. Lbs.)	15
Bushing Diameters (I.D.)	
Commutator End Frame	0.540"-0.544"
Shift Lever Housing	0.810"-0.813"
Nose Housing	0.625"-0.627"
Starter Solenoid Model	1119895
Current Consumption @ 80° F.	
Both Windings	
Amperes	65.3-73.3
Volts	10
Hold-in Winding	
Amperes	12.7-14.3
Volts	10

Generator

The generating system consists of an engine-driven, oil-cooled brushless generator, a transistorized voltage regulator, and a starter control and generator relay. Information concerning the transistorized voltage regulator is covered in "REGULATOR" section later in this group. The starter control and generator relay is covered under "Relays" in "WIRING AND MISCELLANEOUS ELECTRICAL" section.

IMPORTANT

The electrical system on these coaches is NEGATIVE GROUND. It must be emphasized that if the batteries are not connected for a NEGATIVE GROUND system, severe damage to the generator, regulator, batteries, and battery cables will result.

GENERAL

The oil-cooled generator is a self-rectifying AC generator in which all current carrying members, windings, built-in diodes, and field coils are stationary. It is a totally enclosed unit, cooled and lubricated by engine oil. The oil inlet is on the diode end cover and the oil drains back into the engine crankcase through the drive end frame and gear train cover as shown in figure 1. The generator should never be operated with the oil line disconnected.

Power output is DC with a maximum rating of 220 amperes. It will produce 120 amperes at normal engine idle speed.

The generator has three terminals (fig. 2); the DC power output terminal, a field terminal, and a relay terminal. The relay terminal provides voltage only for the starter control and generator relay. Generating system wiring diagram is schem-

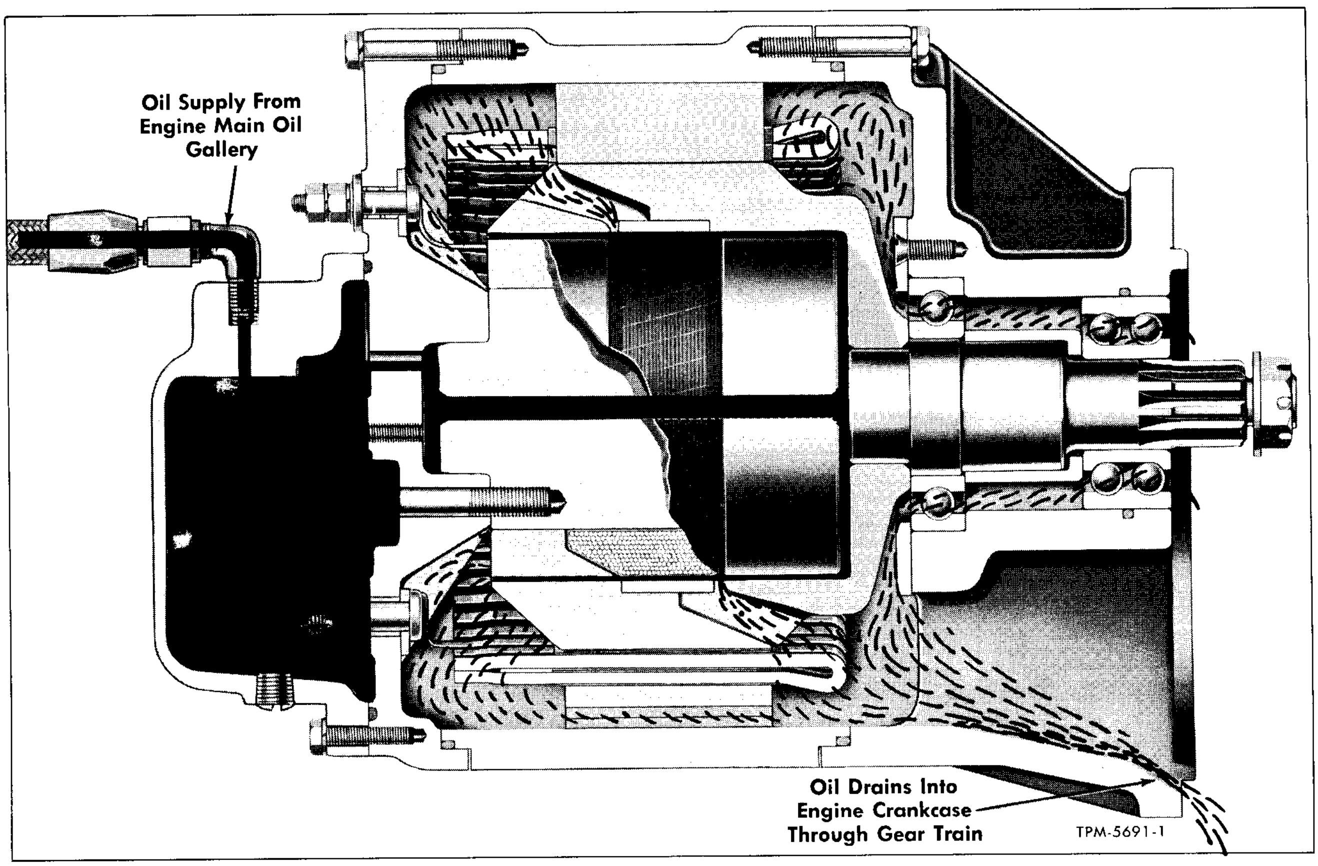


Figure 1—Oil Circulation Through Generator

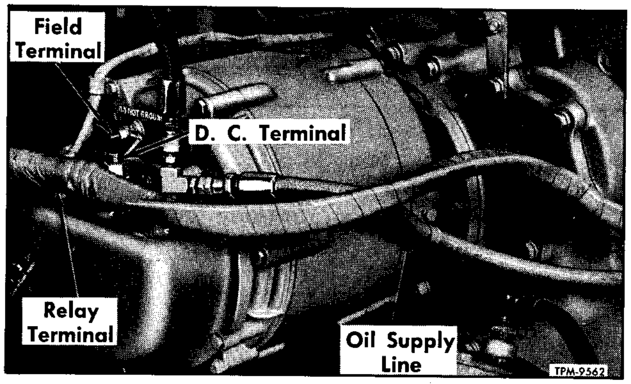


Figure 2—Oil-Cooled Generator Installed

atically illustrated in figure 3. Refer to "Engine Control and Generator Wiring Diagrams" in back of this manual for complete electrical circuit diagram.

The generator has inherent current regulation so that an external current regulator is not needed. The use of silicon diodes eliminates the need for a cut-out relay, since current cannot flow in reverse direction through the diodes.

PRECAUTIONS

1. Electrical system is NEGATIVE GROUND. Connecting the batteries with positive ground will result in severe damage to the generator, regulator, batteries, and battery cables.

2. The common trouble-shooting practice of momentarily grounding the generator field terminal to determine presence or absence of field power MUST BE AVOIDED. Grounding the generator field terminal will instantly overload and destroy the transistors within the regulator.

3. The generator output terminal is energized whenever the batteries are connected. If work is to be done near the generator, the batteries should be disconnected to prevent accidental grounding at the generator power output terminal.

MAINTENANCE

Because of the absence of brushes, commutator, and rubbing seals, the generator requires no periodic maintenance.

ON-VEHICLE CHECKS

Abnormal operation of the generating system is indicated by a tell-tale in the instrument panel in front of driver. Normally, the tell-tale will light up when "MASTER" switch is placed in either "DAY" or "NITE" position, and will remain on until engine is started and generator is charging. If tell-tale comes on during operation, or if it fails to light when "MASTER" switch is turned on, trouble in the generating system is indicated. The following quick checks will determine if the trouble is in the generator, or starter control and generator relay. If trouble is found not to be in one of these units, refer to "REGULATOR" section later in this group for further checks. Any unit which is found to be defective must be replaced. Internal

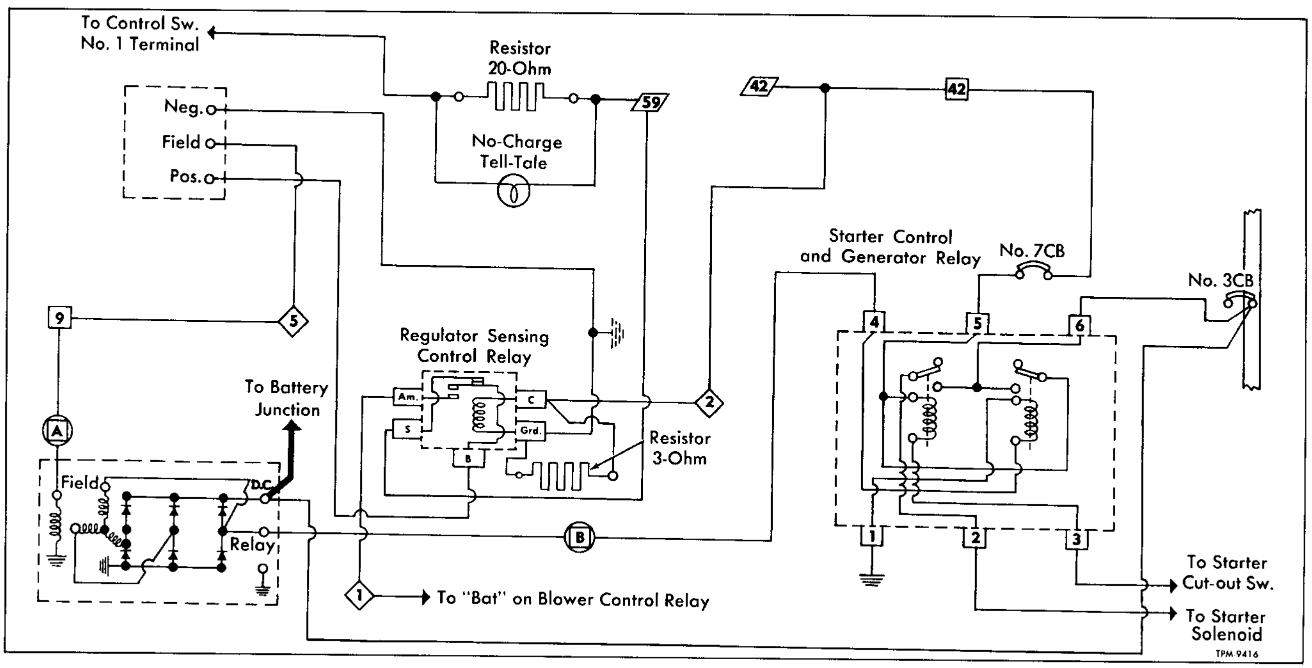


Figure 3—Generating System Schematic Wiring Diagram

checks of the generator components can be made as directed later under "Generator Repair."

PRELIMINARY CHECKS

First check the entire generating system for loose connections and broken wires. If generator no-charge tell-tale fails to light when "MASTER" switch is turned on (before engine is started), make sure tell-tale bulb is not burned out.

GENERATOR

Generator Output Check (Fig. 4)

1. Disconnect battery cable at battery.
2. Disconnect all leads from regulator and disconnect lead from generator field terminal.

CAUTION: Do not allow leads to touch ground.

3. Connect a voltmeter and ammeter in circuit as shown in figure 4.
4. Connect a jumper lead from generator "DC" terminal to generator field terminal as shown.
5. Connect a carbon pile load across battery as shown.

NOTE: Make sure carbon pile is turned off.

6. Reconnect battery cable at battery.
7. Start engine and operate at approximately 1500 rpm (3100 generator rpm).
8. Turn on all vehicle accessories and adjust carbon pile load until a 220 ampere current draw is shown on ammeter.
9. Check voltmeter; a minimum voltage reading of 13.7 volts should be obtained.
10. If generator fails to perform as explained in steps 8 and 9, generator is defective. Check component parts of generator as explained under "Troubleshooting."

Shorted Diodes

A shorted diode in the output side of the rectifying bridge of the generator will operate the starter control and generator relay. This will be evidenced by:

1. Starter will not operate.
2. The no-charge tell-tale lamp will not light when engine is not running and "MASTER" switch is in "DAY" position.

When the above conditions exist, check diodes and replace defective units as directed later under "Generator Repair."

STARTER CONTROL AND GENERATOR RELAY

This unit has a dual function - One relay energizes the starter solenoid; the other relay is powered from the relay terminal of the generator and closes when the generator is charging. The two relays are interconnected so that when the generator is charging the starter relay will not operate if the starter switch is closed.

1. Connect voltmeter leads to generator "Relay" terminal and to vehicle ground.
2. Start engine. A reading of 6 to 7 volts is normal and indicates proper feed to relay.
3. Connect voltmeter leads to No. 5 terminal of relay and to vehicle ground. Voltmeter should read battery voltage when generator is charging. No voltage indicates a defective relay.

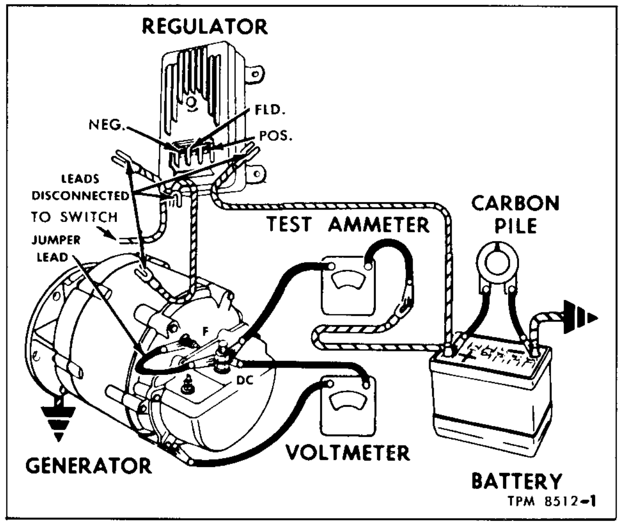


Figure 4—Checking Generator Output

GENERATOR REPLACEMENT

REMOVAL

Refer to figure 5.

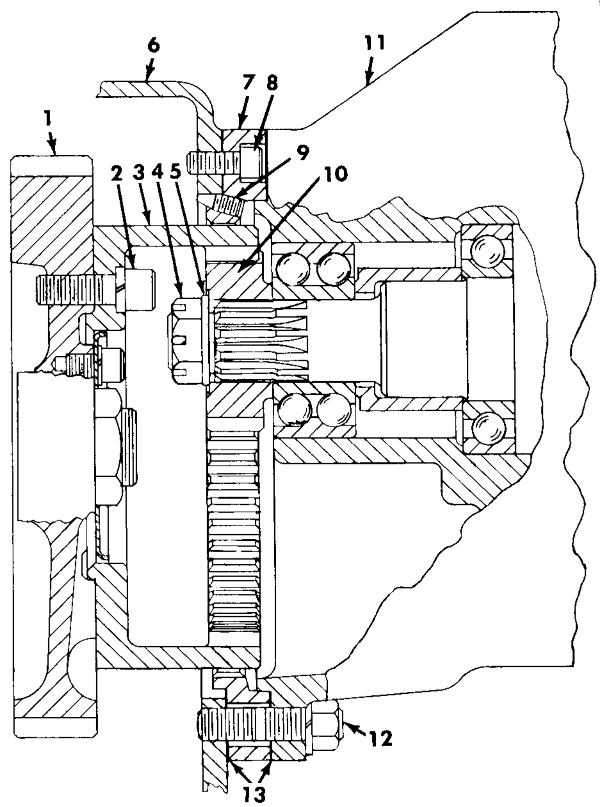
1. Remove drain plug from bottom of diode end cover and drain oil into a container. Reinstall drain plug after draining.
2. Disconnect wires from "F" and "RELAY" terminals and disconnect battery cables from "DC" terminal on diode end cover. Tape ends of battery cables to prevent short circuit, and tag wires removed from other terminals for identification at time of installation.
3. Disconnect flexible oil supply line from elbow on diode end cover. Remove clip securing flexible oil line to bracket on generator drive end frame.
4. Remove nuts and lock washers from six mounting studs. Pull generator straight back off mounting studs to complete removal.
5. If a new or rebuilt generator is to be installed, remove driven gear for installation on replacement unit.

INSTALLATION

Key numbers in text refer to figure 5.

1. Before installing generator, inspect drive gear (3) for worn or damaged teeth. If wear or damage is evident, drive gear must be replaced as follows:

GENERATOR



1 Balance Shaft Gear	8 Socket-Head Screw
2 Socket-Head Screw	9 Socket Head Screw
3 Drive Gear	10 Driven Gear
4 Gear Retaining Nut	11 Generator End Frame
5 Flat Washer	12 Mounting Stud
6 Gear Train Cover	13 Gaskets
7 Spacer Ring	

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Figure 5—Generator Drive

a. Remove six socket-head set screws (2) and lock washers attaching internal-toothed drive gear (3) to engine balance shaft gear (1). Remove gear.

b. Position new drive gear (3) on balance shaft gear (1), with pilot on drive gear entering pilot bore in balance shaft gear. Install six socket-head set screws (2) with lock washers and tighten firmly.

c. Clamp a dial indicator to drive gear (3) in such a manner that indicator pin will contact the generator end frame pilot bore in the spacer ring (7). Turn engine over with starter while observing reading on dial indicator. Run-out of pilot bore with axis of shaft should not exceed 0.002" total indicator reading. If necessary, loosen three socket-head set screws (8) and adjust tapered set screws (9) to locate spacer ring within limits. After the proper concentricity is obtained, tighten spacer ring attaching set screws (8) to 8-12 inch-pounds torque.

2. Install drive gear (10) on generator rotor shaft and secure with flat washer (5) and nut (4). Tighten nut to 180 foot-pounds torque and secure with cotter pin.

3. Place gasket (13) over generator mounting studs. Position generator assembly on engine, with holes in end frame flange over mounting studs (12) and with teeth of driven gear engaging teeth in drive gear. Install lock washers and nuts on mounting studs and tighten firmly.

4. Connect flexible oil line to elbow on diode end cover. Secure oil line in clip on bracket attached to generator drive end frame.

IMPORTANT

Foreign material may clog the oil inlet orifice in the diode end cover. When replacing or connecting oil line, use extreme care to prevent foreign material getting into the oil line or fitting.

5. Connect wires to "F" and "RELAY" terminals and connect battery cables to "DC" terminal. Tighten terminal nuts firmly.

6. Make sure drain plug is installed and securely tightened in diode end cover.

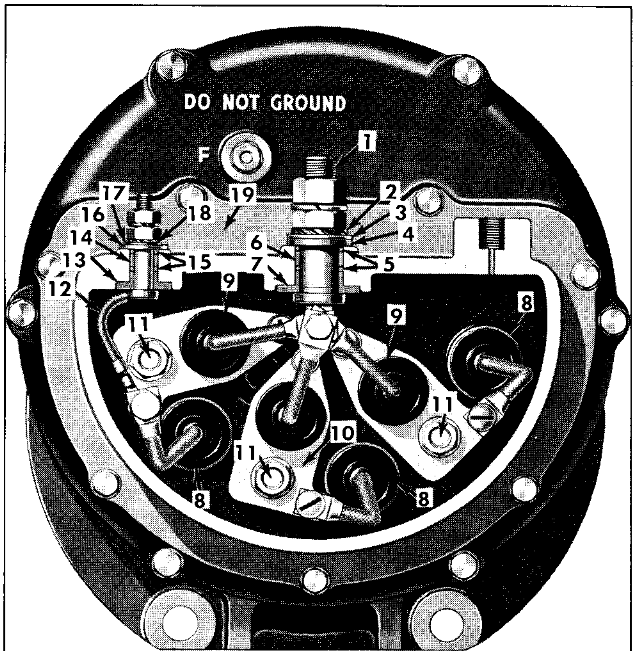
7. NOTE: When oil was drained from the diode end cover, this removed approximately one quart of oil from the engine oil supply. After running engine to fill the diode end cover, check engine oil level and replenish as necessary as directed in LUBRICATION (SEC. 13).

TROUBLESHOOTING

GENERAL

It is not necessary to completely disassemble the generator to make electrical checks. All electrical checks are made at the diode end of the assembly without disassembling the rotor, drive end frame, and bearing. If electrical components are not defective, but bearing replacement is necessary, this is accomplished at the drive end without disassembling the diode end of the unit as explained under "Generator Repair."

These procedures are based on the assumption that "On-Vehicle Checks" have indicated that the generator is malfunctioning and that the generator has been removed from the engine as previously directed under "Generator Replacement."



1 Output Terminal Stud
2 Toothed Lock Washer
3 Flat Washer
4 Insulating Washer
5 O-rings
6 Insulating Sleeve
7 Insulating Bushing
8 Diode (in end frame)
9 Diode & Support Assy. (R.H. & L.H.)
10 Diode & Support Assy. (Center)
11 Stator Terminal Studs
12 Relay Terminal Stud & Lead Assy.
13 Insulating Bushing
14 Insulating Sleeve
15 O-rings
16 Insulating Washer
17 Flat Washer
18 Toothed Lock Washer
19 Diode End Cover

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Figure 6—Cutaway View Through Diode End Cover

DIODE END COVER REMOVAL

In order to remove the diode end cover, it is necessary to remove the output terminal stud and relay terminal stud attaching nuts so the studs can be withdrawn from the end cover as the cover is removed from the diode end frame.

1. Remove all nuts, lock washers, flat washers, and insulating washers from the output and relay terminal studs (fig. 6). Tap studs lightly to loosen, then push studs down into diode end cover.

2. Remove seven cap screws and lock washers attaching diode end cover to end frame. Remove end cover from end frame, at the same time completing removal of terminal studs from end cover. Remove O-ring seal from end frame, and remove terminal stud insulating sleeves, O-rings, and insulating bushings from end cover.

3. Disconnect all diode flexible leads, three from output terminal stud and three from diode supports (fig. 7).

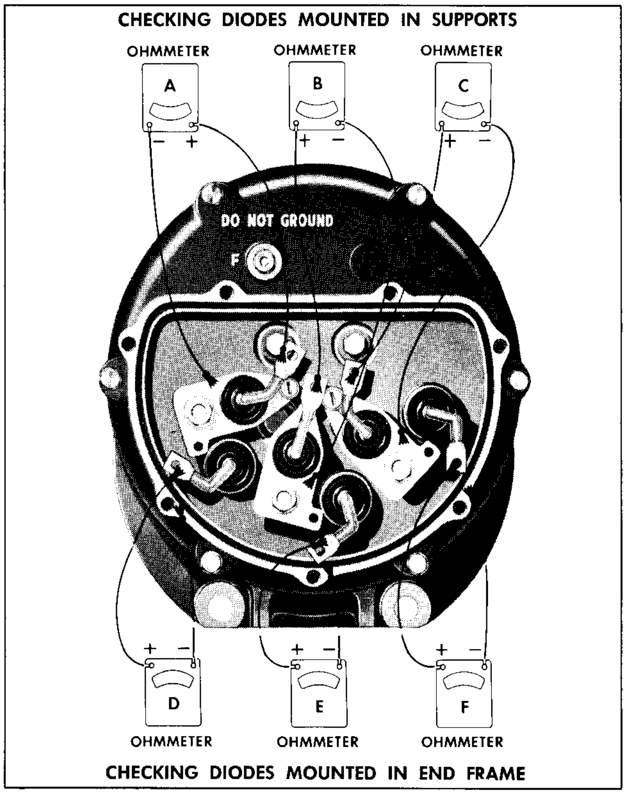


Figure 7—Checking Diodes For Shorts

DIODE CHECKS

NOTE: When checking diodes for shorts and opens, use an ohmmeter with a 1-1/2 volt cell. Select a scale on which the 300 ohm value lies within the middle third of the scale.

CHECKING DIODES FOR SHORTS

If a reading of 300 ohms or less is obtained in either of the checks below, most likely the diode being tested is defective. Diode should be replaced as explained under "Generator Repair" later in this section.

Diodes Mounted in Supports

To check diodes mounted in supports, connect the positive lead of ohmmeter to each diode lead and the negative lead to each support as shown in parts A, B, and C of figure 7. If reading of 300 ohms or less is obtained, replace diode.

Diodes Mounted in End Frame

To check diodes mounted in end frame, connect the positive lead of ohmmeter to each diode lead and negative lead to end frame as shown in parts D, E, and F of figure 7. If a reading of 300 ohms or less is obtained, replace diode.

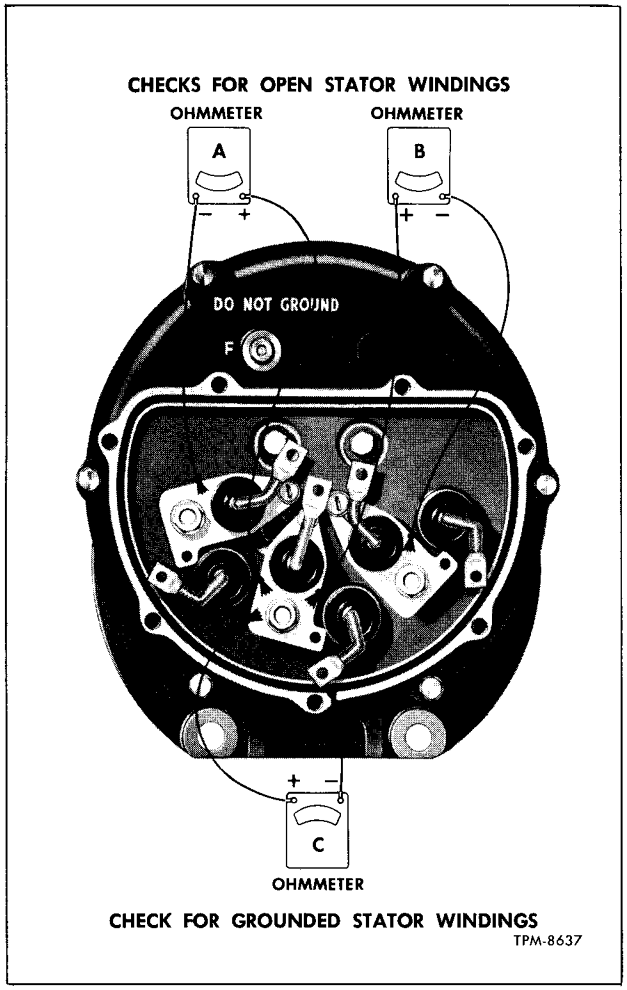


Figure 8—Checking Stator Windings

CHECKING DIODES FOR OPENS

To check diodes for opens, reverse leads of ohmmeter and accomplish procedures given under "Diodes Mounted in Supports" and "Diodes Mounted in End Frame." An infinite resistance reading indicates an open diode.

FIELD WINDING CHECKS

Two methods can be used in checking field windings for opens, grounds, and shorts. The preferred method is to check the resistance of field windings, and the alternate method is to check the amperage draw of the field windings.

PREFERRED METHOD

With lead disconnected from "F" terminal, connect an ohmmeter (selected to a 1-1/2 ohm reading at mid-scale) to terminal and diode end frame. A resistance reading of 1-1/2 ohms will indicate normal field windings. A resistance reading in excess of 1-1/2 ohms will indicate open field windings. A resistance reading less than 1-1/2 ohms will indicate shorted or grounded field windings.

NOTE: Due to temperature conditions, the resistance reading will vary a fraction of an ohm in some cases.

ALTERNATE METHOD

With diode leads disconnected, connect an ammeter and a 12-volt battery in series with the generator field ("F") terminal and ground (on diode end frame). Field should pass 7.8 to 8.6 amperes with 12 volts applied.

STATOR WINDING CHECKS

OPENS

To check stator windings for open, connect ohmmeter leads to two pairs of diode supports as shown in parts A and B of figure 8. The ohmmeter should show a low resistance. If an infinite or high resistance is obtained in either one or both of the checks, the stator windings are open.

GROUNDS

To check stator windings for grounds, connect an ohmmeter to diode support and diode end frame as shown in part C of figure 8. The ohmmeter should show an infinite or very high resistance. If a zero or very low resistance reading is obtained, the windings are grounded.

SHORTS

The stator windings are difficult to check for shorts without laboratory test equipment due to the very low resistance of the windings. However, if all other generator checks are satisfactory, yet the generator fails to perform according to specifications, shorted stator windings are indicated.

GENERATOR REPAIR

REPLACEMENT OF ELECTRICAL COMPONENTS

NOTE: The replacement procedures which follow are based on the assumption that the diode end cover is still removed and diode leads disconnected as required during the preceding tests.

DIODE REPLACEMENT

IMPORTANT: When replacing a diode, make sure it is designed for a negative ground system. Diode can be identified by the symbol stamped on diode case. The arrow must point toward the diode flexible lead.

The three diodes which are mounted in sup-

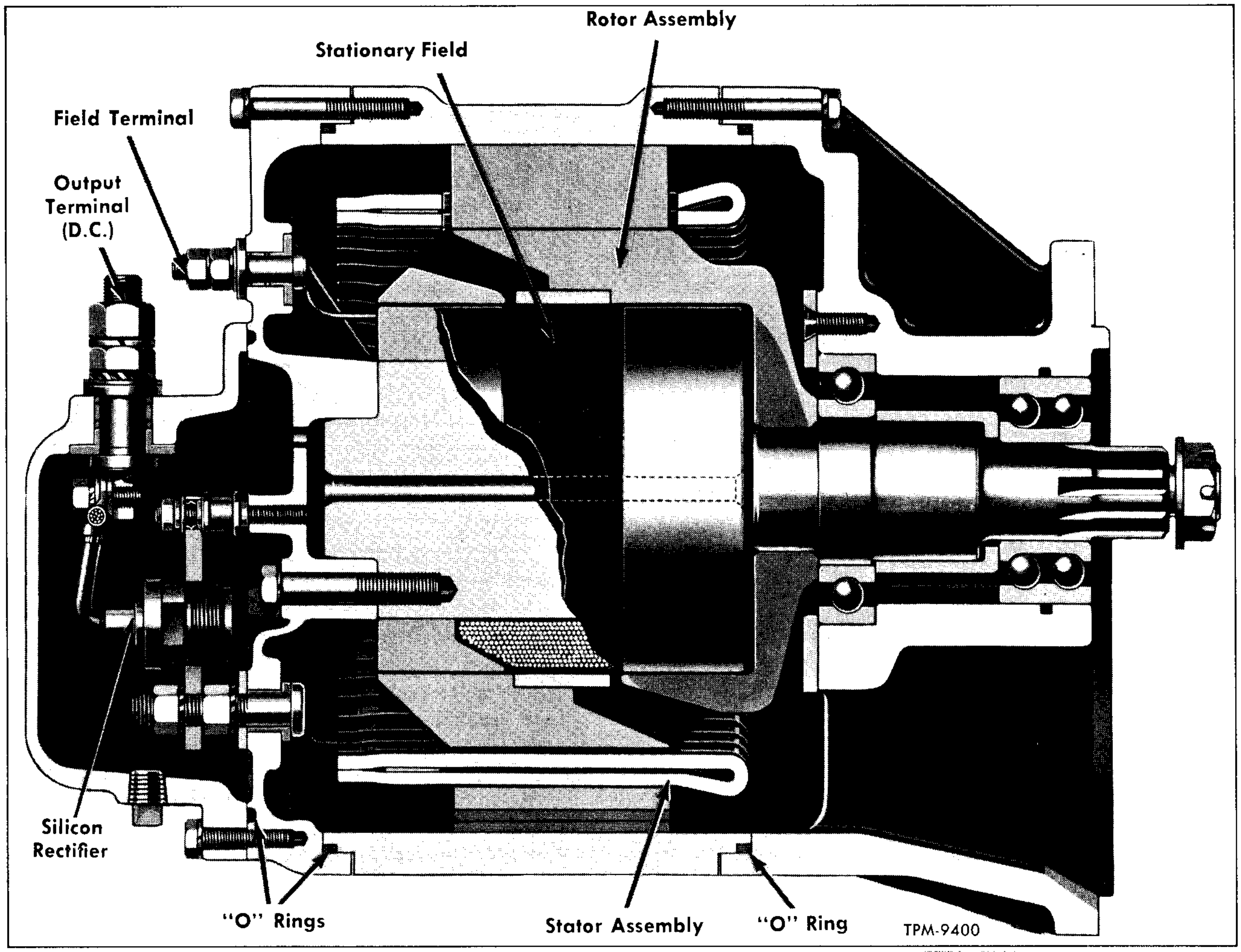


Figure 9—Oil-Cooled Generator Assembly

ports attached to stator lead studs (fig. 6) are serviced only as diode and support assemblies. The two outer diode and support assemblies are identical and can be installed at either side; the center unit has a different support, with 2 inches between mounting hole centers (outer supports have 2-1/4 inch hole centers).

Diode and Support Replacement

Refer to figures 6 and 9 for assembled views.

1. Remove nut w/lock washer attaching diode support to stator lead stud.
2. Remove nut, lock washer, and flat washer attaching support to end frame.
3. Remove diode and support assembly, then remove insert from small hole in support or from small stud in end frame. Also remove insulating sleeve from diode flexible lead.
4. Install insulating sleeve over flexible lead of new diode and support assembly.
5. Place diode and support assembly over stator lead stud and small mounting stud. Place insert over small stud inside the hole in support. Install flat washer, lock washer, and nut on small stud and tighten to 22-25 inch-pounds torque. Install nut w/lock washer on stator lead stud and tighten firmly.

Diode (In End Frame) Replacement

Refer to figures 6 and 9 for assembled views.

The three diodes which are threaded into the end frame are identical. To remove diode, use a thin 1-inch open end wrench on flats of diode case to unscrew diode from end frame. Coat threads of new diode with silicone grease, thread into end frame and tighten to 15-18 foot-pounds torque.

If no other parts are to be replaced, refer to "Diode End Cover Installation" later to complete the assembly.

FIELD REPLACEMENT

Refer to figure 9 for assembled view.

Removal

1. Remove three diode and support assemblies from end frame to provide access to the two lower field to end frame bolts.

2. Remove nut w/lock washer and flat washer from three stator lead studs.

3. Remove six bolts and lock washers attaching diode end frame to stator frame.

4. Separate end frame from stator frame and withdraw end frame and field assembly from rotor, at the same time pushing stator lead studs out of end frame.

5. Remove nut, lock washer, flat washer, and insulating washer securing field lead terminal stud in end frame. Push stud out of end frame.

6. Remove four bolts and lock washers attaching field to end frame.

7. To separate field from end frame, install four 3/8-24 x 3" bolts in place of the 3/8-24 x 2" attaching bolts removed in step 6. Thread bolts in to equal heights. Support end frame in arbor press, and using a suitable press plate to exert force on all four bolt heads, press field out of end frame.

Installation

1. Position field assembly at end frame, insert four 3/8-24 x 3" bolts through end frame, and thread into field to keep holes aligned.

2. Support end frame on arbor press bed in such a manner that the diodes will not be damaged and press field into end frame. Press in until shoulder on field core bottoms against end frame.

3. Remove the four guide bolts. Install four 3/8-24 x 2" bolts, using new lock washers, attaching field to end frame and tighten securely.

4. Place insulating bushing in inner side of field terminal stud hole in end frame and insert stud through bushing. Place an O-ring, insulating sleeve, and another O-ring over field terminal stud and push these parts into end frame. Install insulating washer, flat washer, toothed lock washer, and nut on terminal stud and tighten firmly.

5. Install each of three stator lead studs in end frame as follows: Place insulating washer over stud and insert stud through end frame. Place insulating bushing over stud and position in hole in end frame. Install flat washer and nut w/lock washer on stud and tighten firmly.

6. Install three diode and support assemblies on end frame as previously directed under "Diode Replacement."

7. Install new O-ring seal in notch around end of stator frame. Insert field into rotor and position end frame against stator frame. Attach end frame to stator frame with six bolts and lock washers. Tighten bolts firmly.

8. If no other parts require replacement, refer to "Diode End Cover Installation" later to complete the assembly.

STATOR REPLACEMENT

Refer to figure 9 for assembled view.

If tests indicated an open circuit or short in the stator, the stator and frame assembly must be replaced.

Removal

1. Remove diode end frame and field assembly as previously directed in steps 1 thru 4 under "Removal" in "Field Replacement" procedure.

2. Remove six bolts and lock washers attaching stator frame to drive end frame.

3. Separate stator frame from drive end frame and remove from end frame and rotor.

Installation

1. Position new O-ring seal (5) in notch around drive end of stator frame.

2. Position stator and frame assembly over rotor against drive end frame. Attach stator frame to drive end frame with six bolts and lock washers. Tighten bolts firmly.

3. Install diode end frame and field assembly as directed in steps 5, 6, and 7 under "Installation" in "Field Replacement" procedure.

4. Install rectifier end cover as directed later.

DIODE END COVER INSTALLATION

Refer to Figures 6 and 9 for assembled views.

1. Make sure all diodes are properly installed and securely tightened. Leads from diodes threaded into end frame must be securely attached to diode supports. Relay terminal lead must also be attached to left diode support as shown in figure 6.

2. Connect leads from three diodes mounted in supports to output terminal stud as shown in figure 6. Tighten attaching screw firmly. Place insulating bushing over output terminal stud and place insulating bushing over relay terminal stud.

3. Place new O-ring seal in groove in diode end frame.

4. As diode cover is positioned at end frame, the output terminal stud and relay terminal stud must be inserted through holes in top of end cover. Wrapping soft wire around stud threads and inserting wires through the holes will facilitate pulling studs through holes. Make sure insulating bushings are on terminal studs.

5. With end cover in place against end frame, install seven attaching cap screws and lock washers. Tighten cap screws firmly.

6. Referring to figure 6, install insulating sleeves and O-rings over output terminal stud and relay terminal stud, and push these parts down into

cover. Make sure insulating bushings are in place in counterbores on underside of cover. Secure each terminal stud in place with insulating washer, flat washer, toothed lock washer, and nut. Tighten nuts firmly.

7. Make sure drain plug is installed and securely tightened in bottom of end cover. Plug oil inlet opening in top of cover to keep out dirt until generator is installed.

BEARING OR ROTOR REPLACEMENT

Whenever rotor and drive end frame are disassembled for any reason, the single row ball bearing must be replaced with a new one due to the probability of its being damaged during disassembly.

REMOVAL AND DISASSEMBLY

Refer to figure 9 for assembled view.

1. If driven gear was not removed from rotor shaft at time of generator removal, remove nut and flat washer from shaft and pull gear off shaft.
2. Remove six bolts and lock washers attaching drive end frame to stator frame. Separate drive end frame from stator frame and remove drive end frame and rotor assembly.
3. Support drive end frame in arbor press in such a manner that the rotor can be pressed down out of end frame. Using a suitable adapter against end of rotor shaft which will pass through the inner race of the double-row ball bearing, press rotor down out of end frame and bearings.
4. Remove six screws attaching bearing retainer plate to drive end frame. Remove retainer plate.
5. Support drive end frame in arbor press, with double-row bearing up, in such a manner that the bearings can be pressed down out of end frame. Using a suitable driver which will exert force on both the inner and outer races of the double-row bearing, press bearings downward out of end frame. (The bearing spacer transmits force from the double-row bearing inner race to the inner race of the single-row bearing; since this force is transmitted to the single-row bearing outer race through the balls, the bearing is likely to be damaged and must be replaced with a new part.)
6. Remove rubber bearing clamp from groove in end frame bearing bore.

ASSEMBLY AND INSTALLATION

Refer to figure 9 for assembled view.

1. Press new single-row ball bearing into inner side of drive end frame. Install bearing retainer plate and attach with six screws. Stake screws in place after tightening.
2. Position rubber bearing clamp in groove in bearing bore in drive end frame. Lubricate clamp to permit bearing to be pressed in without dislodging or damaging the clamp.
3. Position rotor in arbor press with shaft end up. Install drive end frame and single-row bearing assembly over rotor shaft. Using a driver over rotor shaft which will exert force on the bearing inner race, press bearing onto shaft until it bottoms against the rotor.
4. Install bearing spacer over rotor shaft. Position double-row bearing over rotor shaft at end frame bore. Using an adapter which will exert force on both the inner and outer races of the bearing, press bearing onto shaft and into end frame until inner race bottoms against bearing spacer.
5. Place new O-ring seal in notch around drive end of stator frame.
6. Insert the rotor between the stator and field, and position drive end frame against stator frame. Attach end frame to stator frame with six bolts and lock washers. Tighten bolts firmly.

GENERATOR SPECIFICATIONS

Make	Delco-Remy
Model Number	1117670
Rotation	Either
Field Current @ 80° F.	
Amperes	7.8-8.6
Volts	12
Hot Output	
Amperes	220
Volts	14
Approximate rpm	3100
Generator Drive Ratio	2.29 to 1

Regulator

GENERAL

The transistor regulator used on all vehicles covered by this manual is an assembly composed principally of diodes, condensers, resistors, and transistors. These components are mounted on a printed circuit panel board to form a completely static unit containing no moving parts. Regulator terminal connections are marked "NEG," "FLD," and "POS."

The regulator components work together to limit the generator voltage to a pre-set value by controlling the generator field current. This is the only function the regulator performs in the charging circuit.

The voltage at which the generator operates is determined by the regulator adjustment. Once adjusted, the regulator voltage remains constant, since the regulator is unaffected by length of service, changes in temperature, or changes in generator output and speed.

The primary controlling device for the regulator is the Zener diode (D2). The Zener diode is used as a reference source to sense increasing voltage and to turn on the driver transistor (TR2) which in turn shuts off the power transistors (TR1).

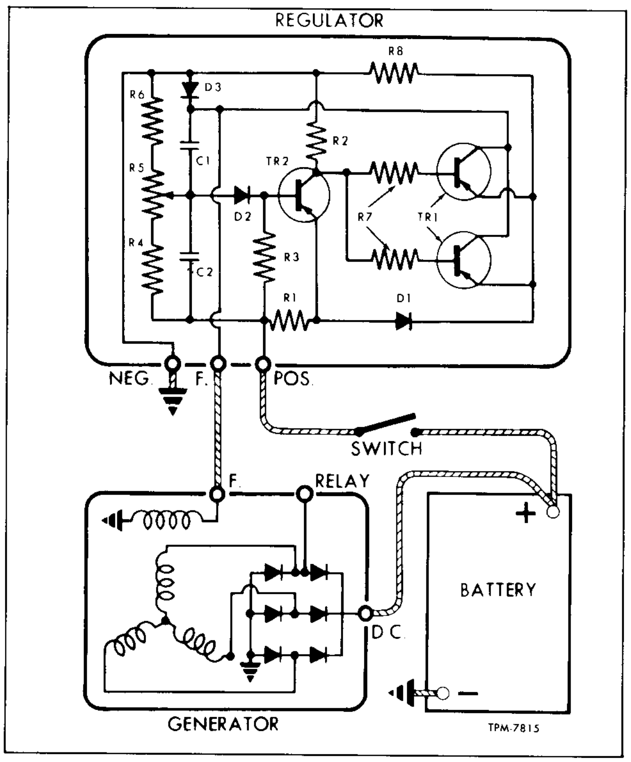
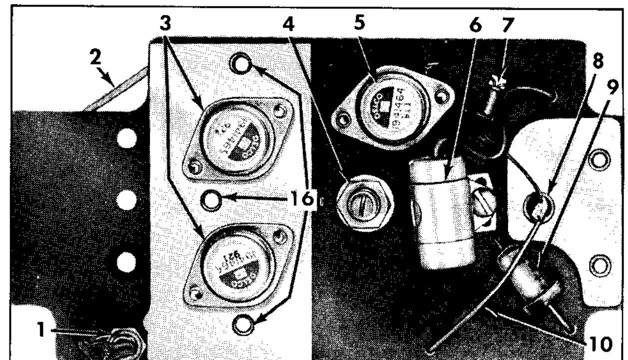


Figure 1—Regulator Circuitry Diagram

With power transistors (TR1) shut off, field current drops until system voltage drops sufficiently to cause the Zener diode (D2) to again allow full field application by the transistors. This action occurs at a varying frequency, depending on generator speed and load.

CAUTION: When performing maintenance on generator or regulator, NEVER ALLOW REGULATOR LEADS TO BECOME GROUNDED.

Figure 1 shows regulator circuitry with each major component identified. Figure 2 shows corresponding items in actual location on panel board in respect to circuitry diagram (fig. 1).



1 Field Discharge Diode (D3)
2 Wire Wound Resistor (R2)
3 Power(Output) Transistors (TR1)
4 Potentiometer (R5)
5 Driver Transistor (TR2)
6 Feed-Back Condenser (C1)
7 Zener Diode (D2)
8 Back-Bias Diode (D1)
9 Filter Condenser (C2)
10 Feed Back Resistor (R1)
11 Wire Wound Resistor (R4)
12 Wire Wound Resistor (R3)
13 Wire Wound Resistor (R8)
14 Wire Wound Resistor (R7)
15 Wire Wound Resistor (R6)
16 Insulators

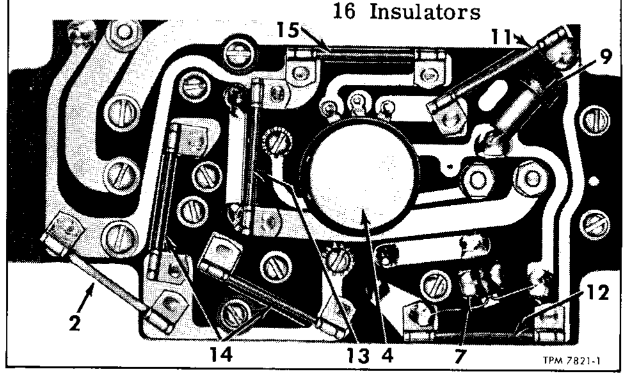


Figure 2—Regulator Components

Regulator is mounted on regulator and blower control panel as shown in figure 6 in "WIRING AND MISCELLANEOUS ELECTRICAL" section. Accessibility to regulator is also described in the same section.

ON VEHICLE ADJUSTMENT

Trouble in the electrical system will usually be indicated by one of two conditions - an undercharged or an overcharged battery. Either condition can result from an improper regulator setting.

The ideal voltage setting is the one which will maintain the batteries in a fully charged condition with a minimum use of water. This setting must be determined by the operator according to the particular type of service under which the coach operates. Check and adjust voltage regulator setting as follows: (See fig. 3 for voltmeter connections.)

1. Connect a voltmeter from regulator "POS" terminal to ground.
2. Start engine and operate at approximately 1000 rpm (about 2300 generator rpm).
3. Turn on vehicle blower motors.
4. Observe voltmeter; a steady reading of 13.7 volts should appear. If this reading is not present, remove plug from regulator and adjust potentiometer (fig. 4) until reading is obtained.

NOTE: In some cases, when maximum special electrical equipment is used and an undercharged battery condition results over a period of time, it may be necessary to adjust regulator to 14 volts. If this is the case, operate vehicle a minimum service period of 48 hours and check for an improved battery condition. The same procedure applies for an overcharged battery, except adjust voltage to 13.4 volts.

5. If voltage cannot be adjusted by turning potentiometer, and it is evident that trouble exists in generating system, check generator as directed in "GENERATOR" section of this manual. If generator is found to be satisfactory, check regulator as directed under "Troubleshooting" below.

TROUBLESHOOTING

Various electrical checks can be made to locate defective components. Components to be checked are identified in figure 2.

The ohmmeter used in the following checks must be accurate, and must be one which uses a 1-1/2 volt dry cell. The milliammeter and voltmeter used in figure 5 are as follows: Milliammeter - use the milliammeter ranges of a Simpson Model 240 Multimeter, or any reliable 0-100 milliampere D.C. meter; voltmeter - use the voltmeter range of a Simpson Model 240 Multimeter, or any 0-15 voltmeter with 10,000 ohms/volt or higher movement. The potentiometer used in figure 5 is a 30-ohm, 10-watt unit (part number 1941477).

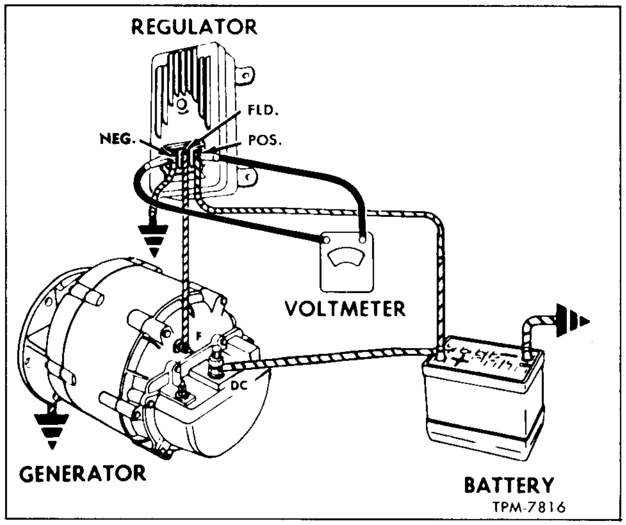


Figure 3—Checking Regulator Voltage Setting

When making checks, note carefully in the illustrations how the ohmmeter is connected with regards to polarity, and select a scale applicable to check being made.

POLARITY OF OHMMETER MUST BE DETERMINED BEFORE FOLLOWING CHECKS ARE MADE.

To determine polarity of ohmmeter, connect one lead to a known positive (+) lead of a voltmeter and other lead to negative (-) lead of voltmeter. If voltmeter reads up-scale, ohmmeter positive (+) lead is connected to voltmeter positive (+) lead and ohmmeter negative (-) lead is connected to voltmeter negative (-) lead.

It is important that the following checks be made in the order listed. If a defective part is found, replace it before proceeding with the remaining checks. Be sure to make all the checks as

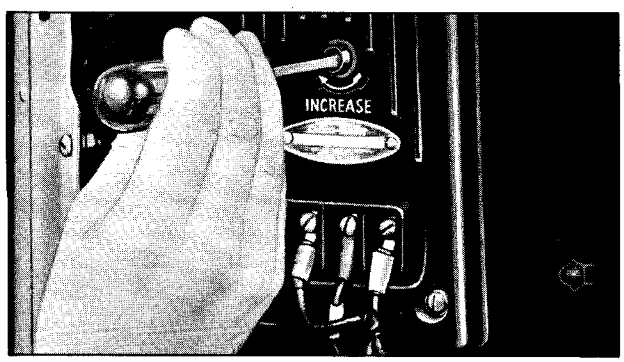


Figure 4—Adjusting Voltage Regulator

REGULATOR

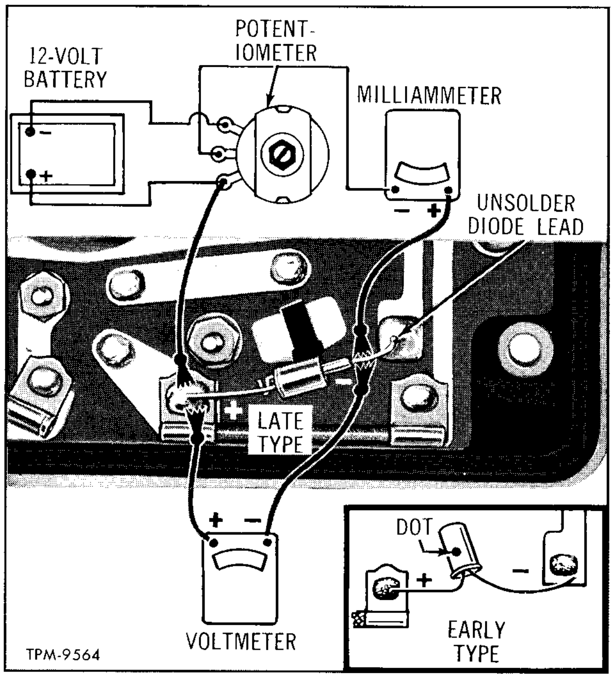


Figure 5—Meter Connections For Checking Zener Diode

more than one component may be defective.

A defective part may be replaced by removing any attaching screws involved and/or unsoldering the connections. To replace the parts identified in figure 2, separate the printed circuit board from the cover by removing eight attaching screws. When resoldering, limit solder time to a minimum, as excessive heat may damage the printed circuit and component parts. However, good soldered connections are essential for satisfactory operation. A rosin core 63% tin 37% lead solder with 350°F. melting point is recommended, along with a soldering iron rated at 50 watts or less. Use extreme care to avoid overheating.

ZENER DIODE

To check the Zener diode (7, fig. 2), unsolder the diode lead and lift up just enough to separate from the printed circuit; bending lead too far may cause it to break off inside the diode. Connect instruments as shown in figure 5, then check as follows:

1. Start with potentiometer at extreme clockwise position.
2. With ammeter set at appropriate scale, rotate potentiometer until milliammeter reads:

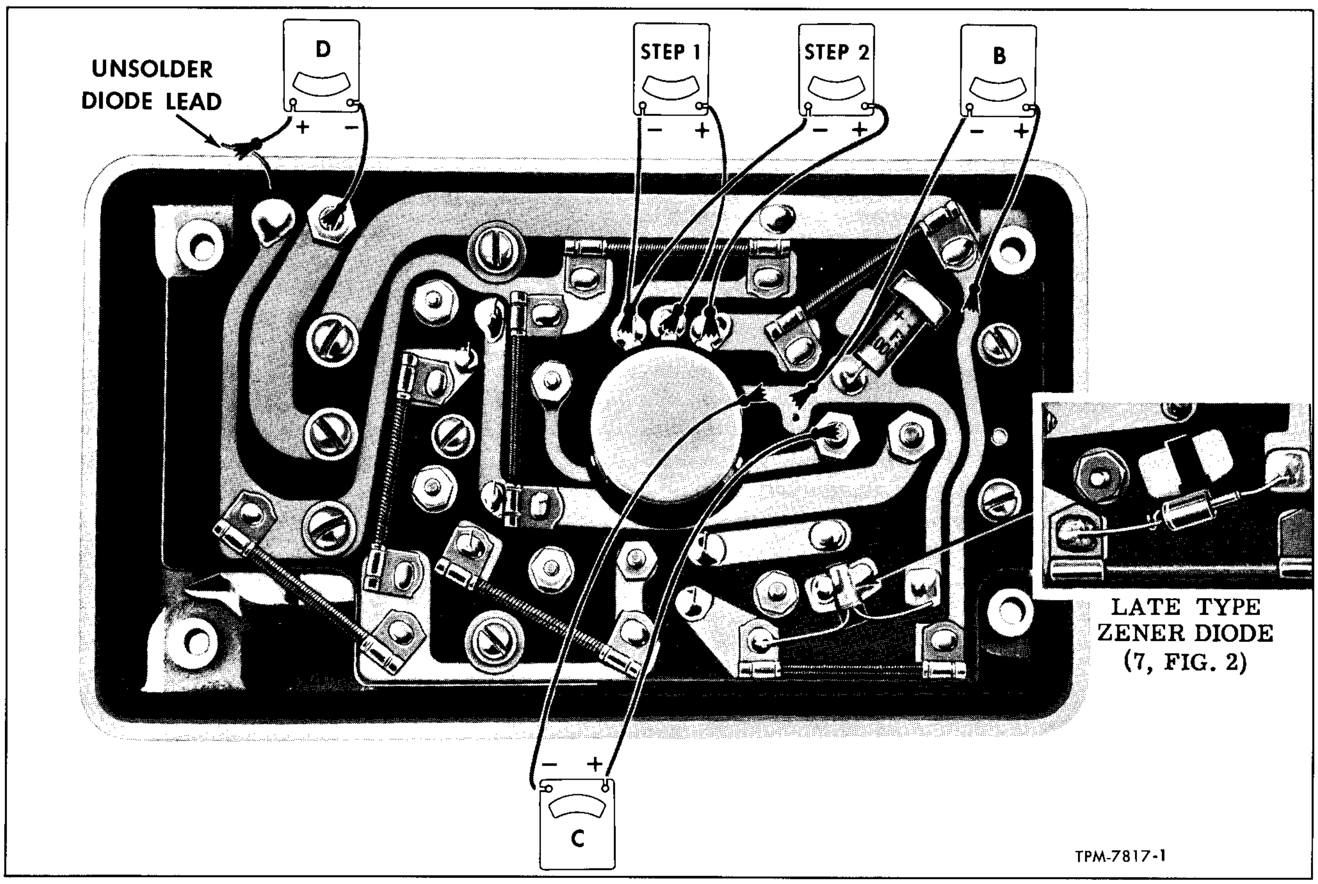


Figure 6—Regulator Component Checks

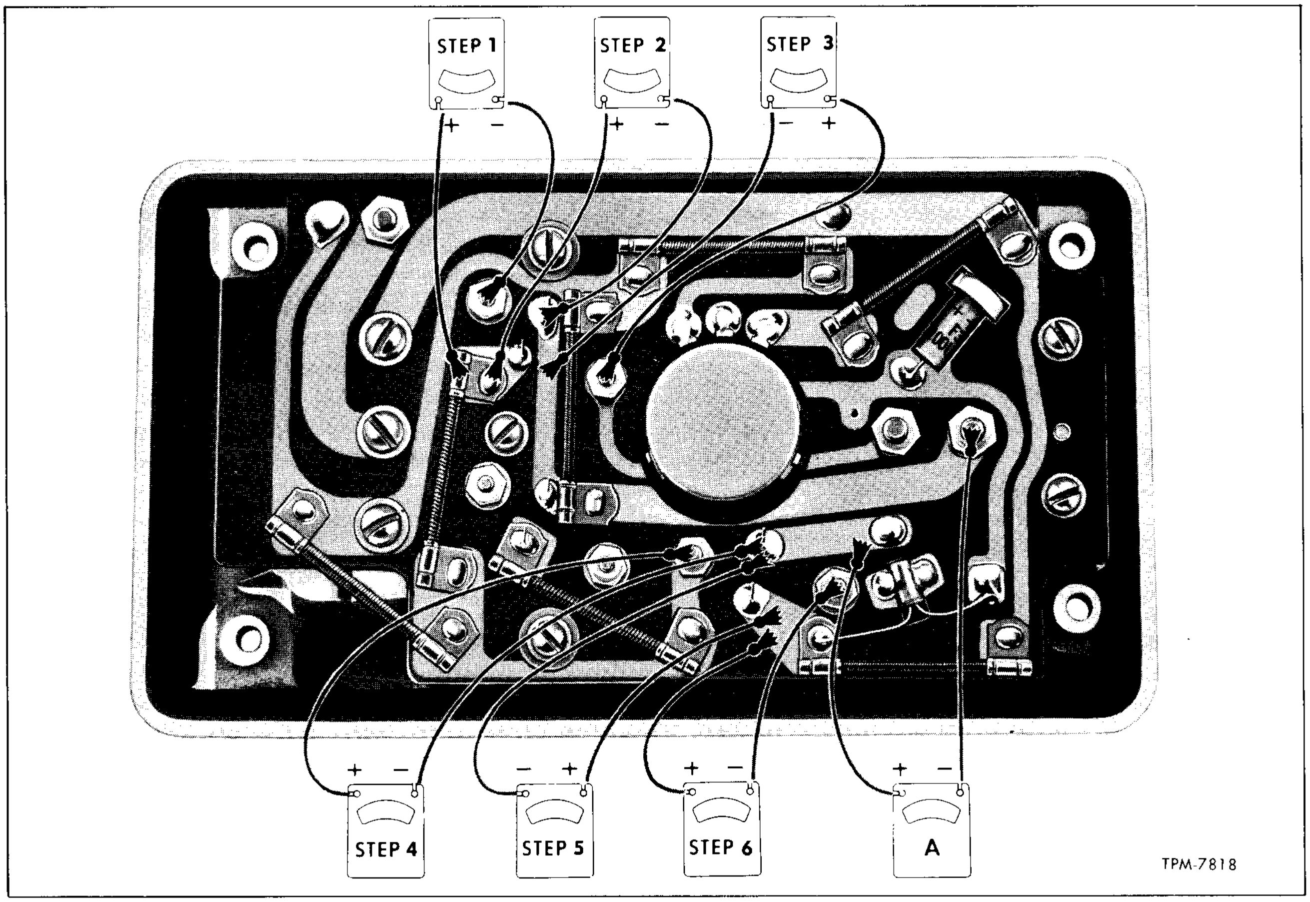


Figure 7—Regulator Component Checks

2 milliamperes - early type
5 milliamperes - late type

Read voltmeter -- limits for both early and late type are 7.4 volts minimum, 10.0 volts maximum.

3. Rotate potentiometer until meter reads:
10 milliamperes - early type
50 milliamperes - late type

Voltmeter reading must not increase more than 0.4 volt (early type) or 0.5 volt (late type) above reading in step 2.

POTENTIOMETER

To check the potentiometer (4, fig. 2), connect ohmmeter leads as shown in Steps 1 and 2 of figure 6. If either reading is 100 ohms or above, potentiometer is open.

FILTER CONDENSER

To check the filter condenser (9, fig. 2), connect ohmmeter leads as shown in Part "B" of figure 6. A zero ohm reading indicates a shorted filter condenser. To check for opens, inspect the two soldered connections for breaks.

FEED-BACK CONDENSER

To check the feed-back condenser (10, fig. 2), connect ohmmeter leads as shown in Part "C" of figure 6. If a zero ohm reading is obtained, condenser is shorted. To check for opens, inspect the soldered connection.

FIELD DISCHARGE DIODE

To check the field discharge diode (1, fig. 2), unsolder lead and connect ohmmeter leads as shown in Part "D" of figure 6. If a zero ohm reading is obtained, diode is shorted. If a very high (infinite) reading is obtained, diode is open.

NOTE: Before proceeding with other check, resolder diode lead.

BACK BIAS DIODE

To check the back bias diode (8, fig. 2), connect ohmmeter leads as shown in Part "A" of figure 7. A zero ohm reading indicates a shorted diode, and a reading over 100 ohms indicates an open diode.

POWER TRANSISTORS

Shorted Transistor

Check the power transistors (3, fig. 2), by

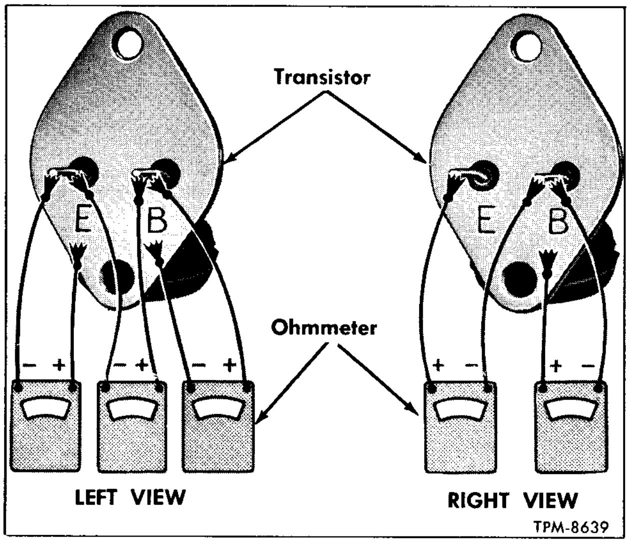


Figure 8—Checking Transistors Removed From Panel Board

connecting the ohmmeter the three ways shown in Steps 1, 2, and 3 of figure 7. If any reading is zero ohms, one of the power transistors is shorted. To determine which power transistor is shorted, or if both transistors are shorted, remove the upper transistor (3, fig. 2) and repeat the check as shown in figure 7 on the transistor which is still mounted on the printed circuit board. If any of the three readings is zero, the transistor is shorted. Also check the transistor which has been removed by connecting the ohmmeter the three ways shown in left view of figure 8. A zero reading in any one of the three checks indicates a shorted transistor.

Open Transistor

Check power transistors for opens by removing transistor from panel board and connecting ohmmeter to each transistor as shown in right view of figure 8. A very high (infinite) reading in either check indicates an open transistor.

DRIVER TRANSISTOR

Shorted Transistor

Check the driver transistor (5, fig. 2) by connecting ohmmeter as shown in steps 4, 5, and 6 of figure 7. The transistor being checked is shorted if a zero ohm reading is obtained.

Open Transistor

Check the driver transistors for opens as explained under "Power Transistors."

REGULATOR SPECIFICATIONS

Make	Delco-Remy
Type	Transistorized
Model Number	9000551
Polarity	Negative Ground
Quantity of Transistors	
Power (output)	2
Driver	1
Voltage Setting	13.7 (see text)

Lighting System

All interior and exterior lights and their controlling switches, relays, and circuit breakers except tell-tale lights, stop and directional lights, and other miscellaneous lights are shown on "Lighting System Wiring Diagrams" in back of manual.

IMPORTANT: All lights should be checked daily and necessary replacements made. Bulb sizes are listed in "Specifications" at end of this section.

SWITCHES AND CIRCUIT BREAKERS

All interior and exterior lights required for normal operation of the vehicle are controlled by the "MASTER" switch on control panel at left of driver. Light circuits which are energized when "MASTER" switch is in "DAY," "NITE," or "PARK" position are listed below under "Master Switch." The destination sign standby lights and dome lights are controlled by secondary switches, interconnected into the master switch circuits; these switches are located on recessed switch panel at left of driver. Engine compartment lights are controlled by a switch on the engine compartment control panel.

All lighting circuits are protected by automatic reset type circuit breakers. Location and rating of all circuit breakers are covered in "WIRING AND MISCELLANEOUS ELECTRICAL" section at beginning of this group.

"MASTER" SWITCH

Master switch circuit positions are marked "OFF," "DAY," "NITE," and "PARK." Selected circuits become energized when circuit caption on switch is rotated into alignment with position indicator button on control panel. Only the lighting circuits controlled by the various switch positions are listed below. Refer to "Master Switch Operation" in "WIRING AND MISCELLANEOUS ELECTRICAL" for listing of all circuits controlled by the master switch.

"DAY" POSITION

1. Directional Light Controls
2. Tell-tale Light Circuits

"NITE" POSITION

1. Directional Light Controls
2. Tell-tale Light Circuits
3. Marker Lights
4. License Plate Light
5. Rear Step Lights (Transit)
6. Entrance Door Step Lights (Operated by Door Switch)
7. Fluorescent Dome and Destination Sign Lights (Transit)
8. Headlights
9. Taillights
10. Destination Sign (Suburban)
11. Dome Lights (Suburban)
12. Reading Lights (Suburban)

"PARK" POSITION

1. Marker Lights
2. Taillights
3. Directional Light Controls
4. License Plate Light
5. Front Step Lights
6. Rear Step Lights (Transit)
7. Destination Sign Standby Lights (Transit) (Operated by Stand-by Sign Switch)
8. Dome Lights (Suburban)
9. Reading Lights (Suburban)
10. Destination Sign (Suburban)

EXTERIOR LIGHTING EQUIPMENT

HEADLIGHTS

Each headlight consists of two 5-3/4-inch Type T-3 sealed-beam lamp units. Outer lights are double-filament units, having upper and lower beams. Inner lights are single-filament units, and are used only in conjunction with the upper beam of the outer units. The inner units are identified as Type 1 and have the numeral "1" molded in top of lens; the outer units are type 2, with the numeral "2" molded in top of lens.

Type T-3 sealed-beam unit lens incorporate three projecting guide points which are optically ground to provide flat surfaces at right-angles to the light beam (fig. 1). This design permits adjustment of the light beams in daylight without the use of an aiming screen and without requiring a large work area. Aiming is accomplished with a "T-3 Safety Aimer, Type B" (J-6663). Instructions for using the T-3 aimers are supplied by the instrument manufacturer. Headlights can also be adjusted without the use of the mechanical aimer as follows:

AIMING PROCEDURE

Inner (High-Beam) Lights (Fig. 2)

1. Position vehicle on level floor with headlights 25 feet from a smooth vertical surface. Surface should be provided with paper or a panel

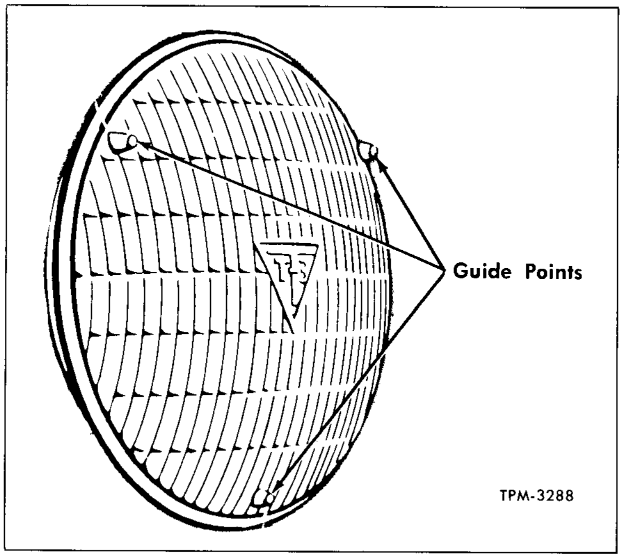


Figure 1—T-3 Headlight Lens

which can be removed to permit drawing two sets of aiming lines. Centerline of vehicle must be at right-angle to the vertical surface.

2. Measure height of headlight centers from floor and mark this height on vertical surface. Draw a horizontal line A-A on vertical surface at this height. Draw a second horizontal line B-B parallel with and 2 inches below line A-A.

3. Locate point at which projected centerline of vehicle intersects these lines and draw a vertical line C-C.

4. Measure distance between centers of inner lights, then divide this distance equally on both sides of centerline C-C. Draw a vertical line (D-D and E-E) through each of these points.

5. Remove headlight bezel for access to adjusting screws. Turn "MASTER" switch to "NITE" position and select high beam with dimmer switch. Cover all lights except one inner light.

6. The high intensity zone of the beam pattern should center at the point where vertical line (D-D or E-E) intersects horizontal line B-B. Turn vertical adjusting screw (fig. 3) to raise or lower the beam pattern, and turn horizontal adjusting screw to move it to right or left.

7. After completing adjustment on one inner light, cover that light, uncover the other inner light, and adjust the other inner light in the same manner.

8. Remove paper or panel from vertical surface to permit drawing aiming lines for outer lights. NOTE: Lines A-A and C-C in figure 2 are in same location for figure 4 and can be located on vertical surface in same place by taking measurements from the removed paper or panel.

Outer (Low Beam) Lights (Fig. 4)

1. Locate projected centerline of vehicle and height of headlight centers (if not marked from previous chart in step 8 above) in same manner

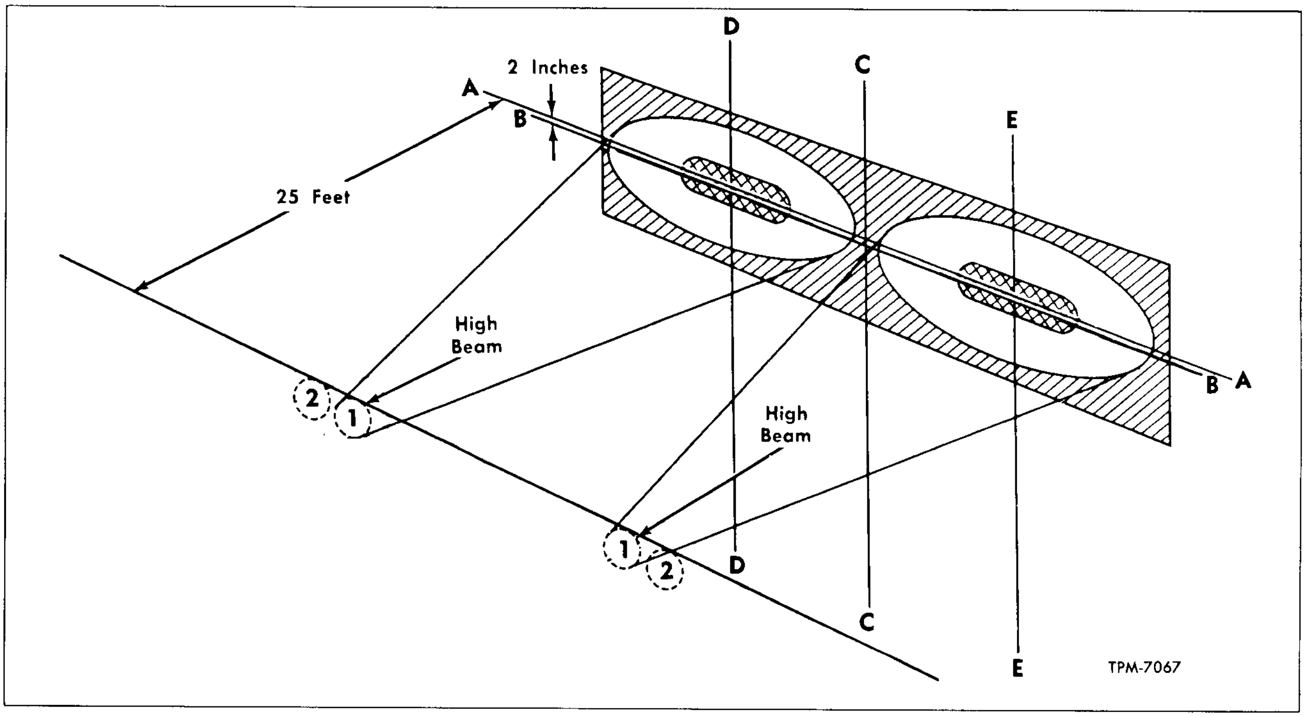


Figure 2—Inner Light (High Beam) Aiming Chart

as in steps 2 and 3 above, except that horizontal line B-B is omitted.

2. Measure distance between centers of outer lights and divide this distance equally on both sides of centerline C-C. Draw a vertical line (D-D and E-E) through each of these points.

3. Turn "MASTER" switch to "NITE" position and select low beam with dimmer switch (inner lights will not be illuminated). Cover one light while adjusting the other. The edge of the intensity zone of the beam pattern must be just below the horizontal centerline (A-A) and to the right of the vertical centerline (D-D or E-E). Turn vertical or horizontal adjusting screws as necessary to obtain this condition.

4. After all lights are properly adjusted, install headlight bezels.

SEALED-BEAM UNIT REPLACEMENT

Removal

1. Remove four screws attaching headlight bezel to front trim panel and remove bezel.

2. Remove two screws attaching sealed-beam unit retaining ring to mounting ring.

3. Unhook spring from retaining ring and remove retaining ring.

4. Remove sealed-beam unit and pull wiring connector plug off back of unit.

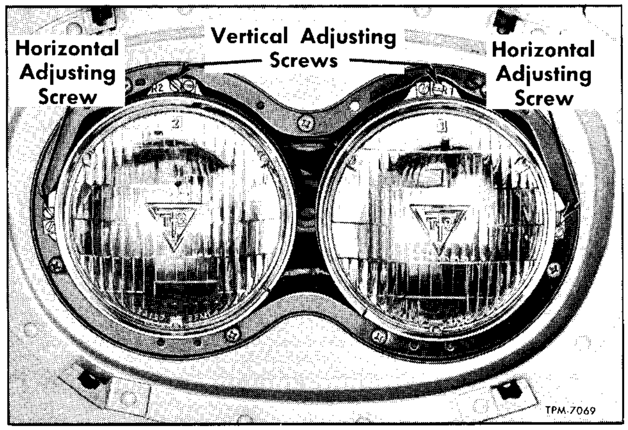


Figure 3—Headlight Adjusting Screws

Installation

NOTE: Sealed-beam unit with number "1" molded in top of lens must be used at inside lights. Unit with number "2" on lens must be used at outside lights.

1. Install wiring connector plug on back of sealed-beam unit. Position unit in mounting ring with lugs on back of unit engaging holes in mounting ring. Molded number on lens must be at top.

2. Position retaining ring over lens and secure to mounting ring with two screws.

3. Hook spring into hole in retaining ring.

4. Adjust headlight beam, either by means of

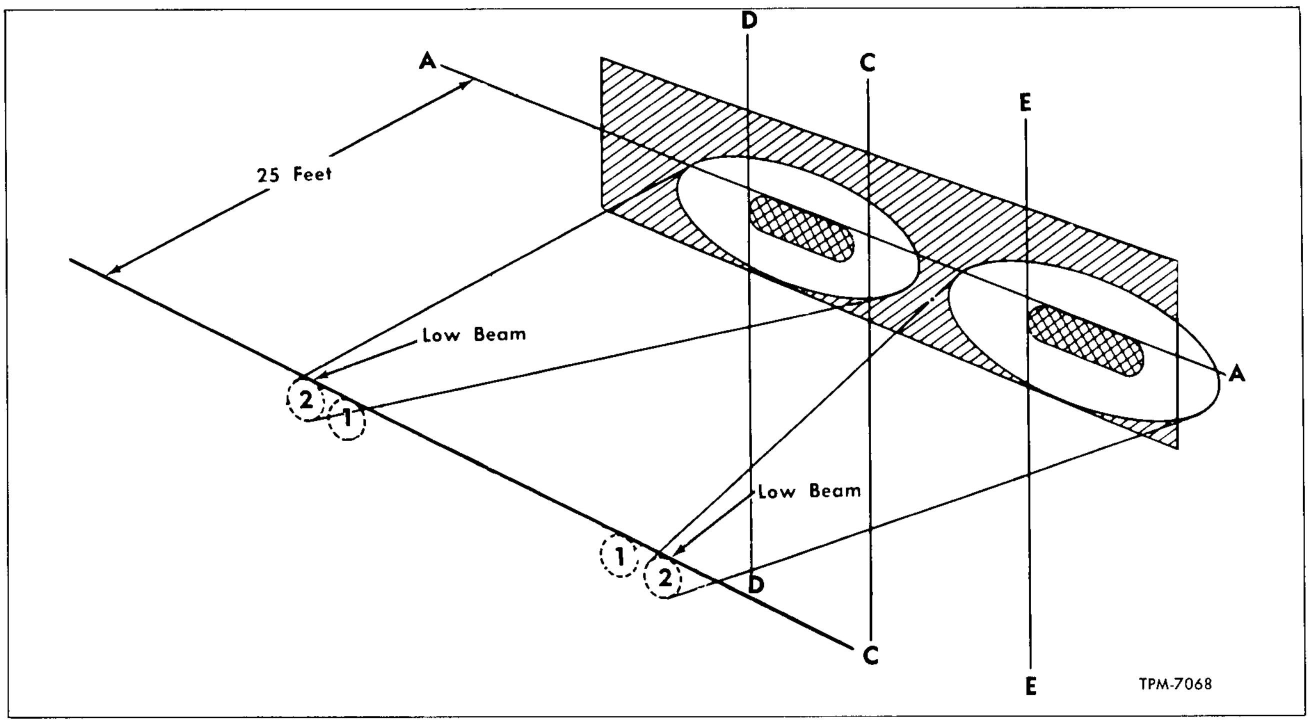


Figure 4—Outer Light (Low Beam) Aiming Chart

LIGHTING SYSTEM

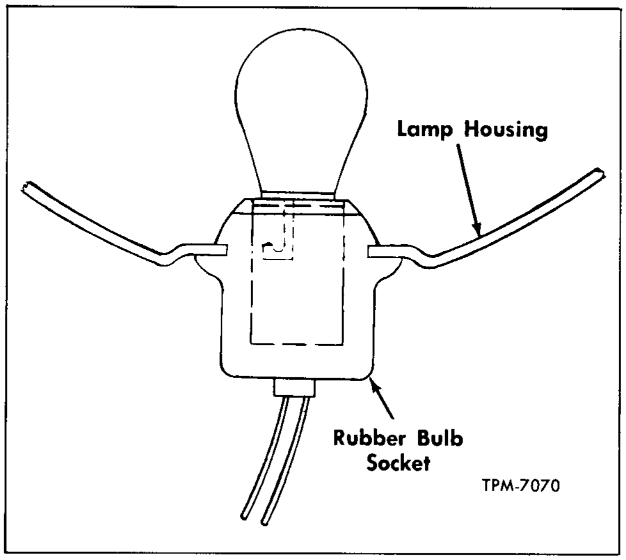


Figure 5—Bulb Socket—Typical For Rear Stop and Directional Lights, Taillights, and Front Directional Lights

a mechanical aimer, or as previously directed under "Aiming Procedure."

5. After completing installation and adjustment, install headlight bezel.

HEADLIGHT DIMMER SWITCH

Foot-operated switch, located on floor of driver's compartment at extreme left side, is used to select headlight high and low beams. Circuit is operative only with "MASTER" switch in "NITE" position. Tell-tale marked "HI BEAM" is illuminated when high beam is being used.

Dimmer switch requires no maintenance other than keeping wiring connections tight. If switch becomes defective it must be replaced. Switch is mounted to underside of floorboard, with switch button extending up through floor into driver's compartment.

IMPORTANT: When replacing switch, the black wire must be connected to the switch terminal marked "BAT." Connect the other two wires to remaining terminals; position of these with respect to terminals is not important.

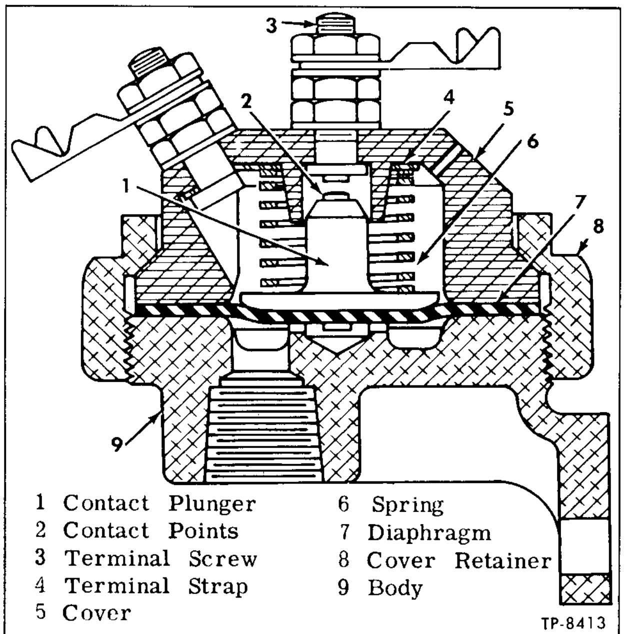


Figure 6—Stop Light Switch

STOP AND DIRECTIONAL LIGHTS

The stop and directional light systems use the same lights. Lights are located on front and rear of coach on both left and right sides. Flasher unit for the directional signal system is protected by number 6 circuit breaker on control panel at left of driver. Stop light system is protected by number 2 circuit breaker in engine compartment apparatus box.

STOP LIGHT SYSTEM

Stop light system consists of two lights, an air-operated switch mounted on top of rear brake relay valve, stop light tell-tale relay mounted in engine compartment apparatus box, and stop light tell-tale light located on driver's gauge and tell-tale panel. Stop light circuit is shown on "Stop and Directional Light Wiring Diagram" at back of this manual.

OPERATION

When brakes are applied and stop lamp switch is closed, current is supplied to left and right stop lights through stop light tell-tale relay and directional signal switch. When stop light tell-tale relay is energized, current is supplied to illuminate stop light tell-tale light. Tell-tale light is illuminated at all times when brakes are applied and stop light switch is closed. When directional signal switch is placed in left or right turn position, stop lights for that particular side flashes on and off.

BULB REPLACEMENT

Bulb socket is molded into a rubber base which fits into the lamp housing in same manner as a rubber grommet (fig. 5). Open engine compartment door for access to back of lamp housing. Grasp bulb socket base and pull out of lamp housing. DO NOT PULL ON WIRES. Remove bulb from socket and install new bulb. Install bulb socket base in lamp housing, pushing base into opening with a twisting motion until inner lip of base slides over the inner edge of the opening. It may be necessary

to use a silicone lubricant on inner lip to facilitate installation.

STOP LIGHT SWITCH (Fig. 6)

Air-operated stop light switch is mounted on top of rear brake relay valve, on crossmember just ahead of rear axle. Switch is actuated by the same air pressure delivered to the top of the relay valve from the brake application valve. When brakes are applied, contacts within switch are closed by air pressure, completing circuit through the stop light relay to stop lights and stop light tell-tale. Shield over switch must be removed for access to switch terminals.

Switch Removal

Remove shield from top of switch. Disconnect wires from switch terminals, then unscrew switch from pipe nipple in top of relay valve.

Switch Repair (Fig. 6)

Disassemble switch and examine diaphragm and contact points. Replace diaphragm if cracked or damaged. If contact points are only slightly burned or pitted, they may be reconditioned using a contact point file. If points are badly damaged, terminal screw and contact plunger with new points should be installed. Replace spring if weakened by rust or corrosion. Make sure vent hole in cover is open.

Switch Installation

Thread switch onto pipe nipple in top of relay valve and tighten firmly. Connect wires to switch terminals, then install shield over switch. With air pressure in system, apply brakes and check operation of stop lights.

STOP LIGHT TELL-TALE RELAY

Operation, maintenance, and adjustment of stop light tell-tale relay are described under "Relays" in "WIRING AND MISCELLANEOUS ELECTRICAL" section at beginning of this group.

DIRECTIONAL SIGNAL SYSTEM

Directional signal system consists of the two stop lights, located on engine compartment door at rear of coach, two lights on front of coach, and on some coaches, two front side lights. Directional signal system on standard vehicles is controlled by directional signal switch located on steering column. On some vehicles, directional signal lights are controlled by separate foot-operated switches (special equipment). Switches are located on angle panel on floor in driver's compartment, just to the left of steering column. A flasher unit is located on control panel at left of driver. Directional signal circuits are shown on "Stop and Directional Light Wiring Diagrams" at back of this manual.

DIRECTIONAL SIGNAL LIGHTS (STANDARD)

Directional signal lights are controlled by a self-cancelling switch mounted on steering column below steering wheel. Pushing switch lever up (forward) turns on right front and rear directional signals, and pulling lever down (rearward) turns on left front and rear directional signals. When turn is completed, switch lever automatically returns to off position. Electrical connections from control panel junction to switch are made through an amphenol connection mounted below the gauge and tell-tale panel.

DIRECTIONAL SIGNAL LIGHTS (SPECIAL)
FOOT OPERATED

Directional signal lights are controlled by separate foot-operated switches. Switches are located on angle panel on floor in driver's compartment, just to the left of steering column. The left switch operates left turn directional signals and the right switch operates the right turn directional signals. Switches are of the momentary-on type and switch button must be held down for full time of desired operation. Switch returns to open position when button is released. Tell-tale marked "DIRECT. SIG." on gauge and tell-tale panel flashes on and off when directional signals are operating, indicating normal operation of the directional signal lights. Directional signal light circuit is protected by number 6 circuit brakes on control panel at left of driver. Electrical circuits are shown on "Stop and Directional Light Wiring Diagram" at back of this manual. Rear directional signal lights are interposed in the stop lights mounted in engine compartment door. When directional signal circuit to stop light is energized, flasher in circuit flashes on and off causing stop light to react likewise. Front directional signal lights are separate units, mounted in each front corner of coach at center sides of headlights. A special side directional signal light is also mounted at top front side of each front wheelhouse (when used).

Bulb Replacement

Rear directional light bulbs are the same bulbs used as stop lights; replacement is previously described under "Stop Lights." Front directional light bulbs are replaced in same manner. Left front light is accessible from inside the coach in driver's compartment; right front light is accessible through the dash compartment door. Side directional light bulbs (above front wheelhousings) are accessible after removing two screws attaching lens to lamp and removing lens.

DIRECTIONAL LIGHT SWITCH (STANDARD)

Operation of directional light switch is previously described under "Directional Signal Lights." Switch is of a repairable type.

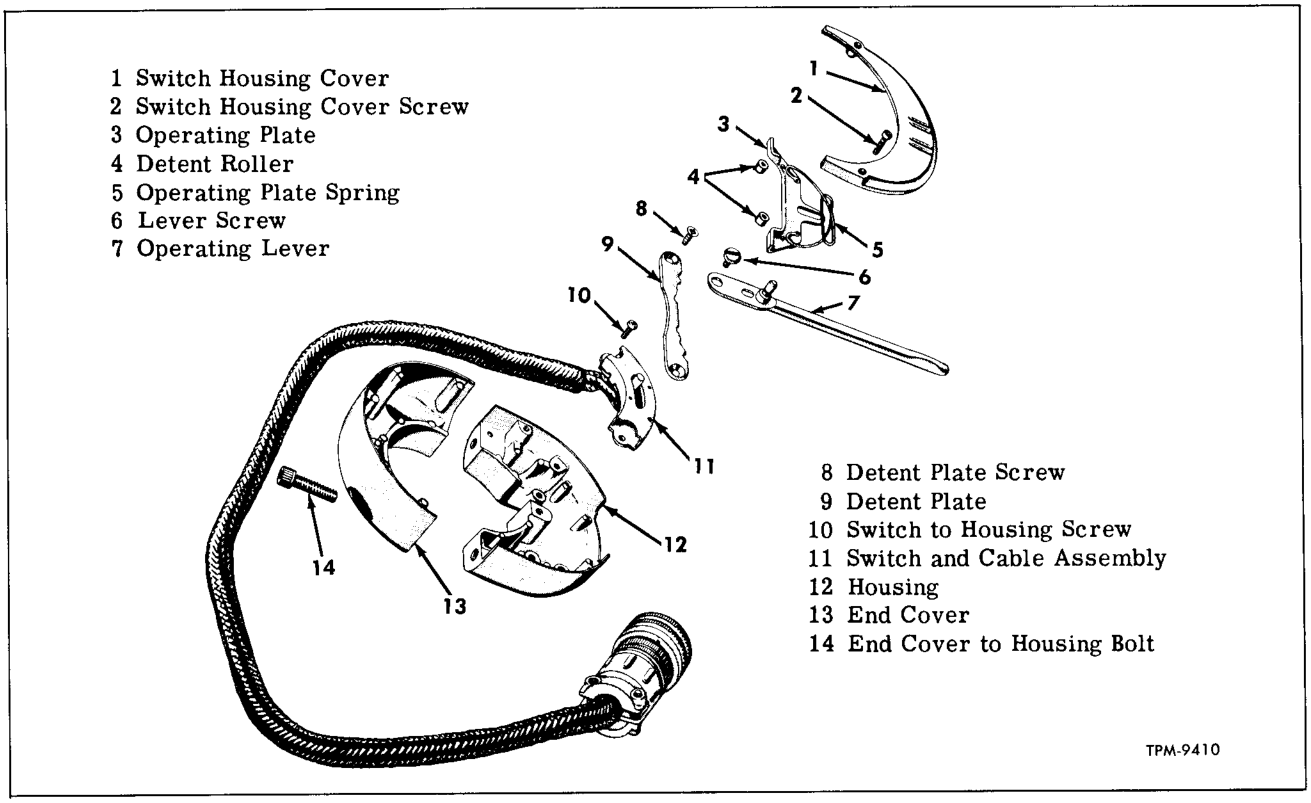


Figure 7—Standard Directional Signal Switch Components

NOTE: Refer to "Steering Wheel Removal" in STEERING (SEC. 16) of this manual for removal of directional signal cancelling plate.

Removal

1. Disconnect amphenol connector mounted below the gauge and tell-tale panel.
2. Remove three screws attaching cable and guard to steering column.
3. Remove two Allen screws attaching end cover and signal housing assembly to steering column. Remove end cover and signal housing assembly from steering column.
4. Remove cable guard from cable.

Disassembly

Key numbers in text refer to figure 7.

1. Remove two screws (2) attaching cover (1) to housing assembly, then remove cover.
2. Remove two screws (8) attaching operating plate (3) and detent plate (9) to housing (12), then remove operating plate and detent plate.
3. Remove operating plate spring (5) and detent rollers (4) from operating plate (3).
4. Remove lever screw (6), then remove lever (7) from housing.
5. Remove two screws (10) attaching switch and cable assembly (11) to housing, then remove switch and cable assembly from housing.

Inspection

1. Inspect switch and cable assembly. If cable is worn, or switch defective, replace.

NOTE: Switch and cable must be purchased as an assembly.

2. Inspect operating plate spring and detent rollers. If worn, replace.
3. Inspect operating plate and detent plate, if worn, replace.
4. Inspect directional switch lever. If worn or broken, replace.
5. Inspect housing, end cover, and housing cover for cracks or worn condition. If cracked or worn, replace.

Assembly

Key numbers in text refer to figure 7.

1. Position switch and cable assembly (11) in housing, attach switch to housing with two screws (10), and tighten screws firmly.
2. Position operating lever (7) over switch and attach lever (7) to housing (12) with one screw. Tighten screw firmly.
3. Install detent rollers (4) and spring (5) in operating plate.
4. Position detent plate (9) in housing (12) and attach with two screws. Tighten screws firmly.
5. Position operating plate (3) on detent plate (9), with spring (5) over lug on operating lever.

6. Install cover (1) on housing (12) and attach with two screws (2). Tighten screws firmly.

Installation

1. Position housing assembly and end cover on steering column and attach with two Allen screws. Tighten screws firmly.
2. Install cable guard on cable.
3. Position cable and guard on steering column and attach with three screws. Tighten screws firmly.
4. Connect amphenol connector below the gauge and tell-tale panel.

FOOT-OPERATED DIRECTIONAL LIGHT SWITCHES (SPECIAL)

Operation of directional light switches is previously described under "Directional Signal Lights." Switches require no maintenance other than keeping connections tight. Switches are non-reparable; if either switch becomes defective it must be replaced.

When connecting wires to switch terminals, it is imperative that certain wires be connected to the correct terminals and to the correct switch (right or left). Terminal numbers are marked on switch housing. Position of terminals on switch do not correspond to position of terminals shown on "Foot-Operated Directional Light Wiring Diagram" at back of this manual. When connecting wires, match wire color to terminal number shown on Wiring Diagram, not to terminal position shown on wiring diagram.

At left switch, the orange wire with black tracer must connect to number 5 terminal; the natural wire with black cross tracer must be connected to number 1 terminal. At right switch, the orange wire with green tracer must connect to number 5 terminal; the natural wire with red cross tracer must connect to number 1 terminal. The other wires, where identical wires connect to both switches, can be connected to either switch, but they must be connected to the correct terminal.

EMERGENCY FLASHER SYSTEM (SPECIAL EQUIPMENT)

Emergency flasher system (when used) utilizes the two stop lights at rear of coach, two directional signal lights at front of coach, and on some coaches, two side directional signal lights. System is operated by emergency flasher switch located on dash panel and flashing cycle is controlled by flasher unit mounted on control panel at left of driver. Emergency flasher system circuit is shown on "Stop and Directional Light Wiring Diagram with Emergency Flashing System" at back of this manual.

OPERATION

When emergency flasher switch is placed in "Emerg. Flasher" position, circuit is completed from "L" terminal of flasher unit through switch to stop lights and directional signal lights. All lights flash at a steady cycle until switch is placed in "OFF" position.

SWITCH

Emergency flasher switch is a double-pole, single-throw, lever type switch, secured to dash panel with a hex-head nut. To remove switch, remove nut and name plate, pull switch from under dash, and disconnect wires.

IMPORTANT: Make sure wires are clearly identified before removing from switch to insure proper position when installing switch.

TAILLIGHTS

Taillights are mounted in engine compartment door below stop and directional signal lights. Taillight circuit is energized with "MASTER" switch in "NITE" or "PARK" position. Taillight circuit, together with all marker lights, door step lights, and instrument panel lights, is protected by number 13 circuit breaker on control panel at left of driver. Taillight circuits and connections are shown on "Lighting System Wiring Diagram" in back of this manual.

BULB REPLACEMENT

Taillight bulbs are accessible and replaceable in same manner previously described under "Stop Lights.

MARKER LIGHTS

A marker light is mounted at each corner of coach near top. Marker light circuits are energized with "MASTER" switch in "NITE" or "PARK" position. Circuit is protected by number 13 circuit breaker on control panel at left of driver. Light bulbs are accessible for replacement after removing lens. Each lens is attached to body with two screws.

IDENTIFICATION LIGHTS (MICHIGAN MARKER)

Six identification lights (Michigan Marker) are mounted - three at rear of coach above window and three at front of coach above destination sign.

Light circuits are energized when "MASTER" switches are placed in "NITE" or "PARK" position. Circuit is protected by number 13 circuit breaker on control panel at left of driver. Front and rear light bulbs are accessible for replacement after removing lens. Each lens is attached to body with two screws.

LIGHTING SYSTEM

DESTINATION SIGN STAND-BY LIGHTS (TRANSIT MODELS)

Four bulbs installed in destination sign compartment can be used as destination sign lights with the fluorescent lights turned off. Lights are controlled by "MASTER" switch in conjunction with the "STAND-BY SIGN" switch on recessed switch panel at left of driver. Lights are illuminated with "MASTER" switch in "NITE" position and "STAND-BY SIGN" switch in "STAND-BY SIGN" position, or with "MASTER" switch in "PARK" position regardless of the position of the other switches.

Bulbs are accessible for replacement through the destination sign compartment door inside the coach. Observe caution on door regarding high voltage in the fluorescent lighting system.

DESTINATION SIGN LIGHTS (SUBURBAN MODELS)

Five bulbs mounted behind destination sign provide illumination for destination sign. Lights are controlled by "MASTER" switch on driver's control panel. When "MASTER" switch is placed in "NITE" or "PARK" position, sign is illuminated. Refer to "Coach Lighting Wiring Diagram" at back of this manual. Bulbs are accessible for replacement through the destination sign compartment door inside the coach.

INTERIOR LIGHTING EQUIPMENT

GAUGE AND TELL-TALE LIGHTS

Gauge and tell-tale light bulbs are mounted in bulb sockets which snap into the gauge and tell-tale housings on under side of panel. Operation of tell-tale lights is explained under "Tell-tale Alarm System" in "WIRING AND MISCELLANEOUS ELECTRICAL" section. To replace any bulb, pull bulb socket out of opening in housing. After replacing bulb, press bulb socket firmly into housing.

STEPWELL LIGHTS (TRANSIT MODELS)

Exit door step lights are illuminated when "MASTER" switch is in "NITE" position. Entrance door step lights are controlled by a door switch, which closes when entrance door is open. Circuit to switch is energized when "MASTER" switch is in "NITE" or "PARK" position. Bulbs are accessible after removing the light lens. Lens is attached to housing with two screws.

ENGINE COMPARTMENT LIGHTS

Engine compartment lights are controlled by a switch on engine compartment control panel. Circuit is protected by Number 2 circuit breaker in engine compartment apparatus box. Bulbs are exposed and are readily accessible for replacement.

EMERGENCY DOOR LIGHT (WHEN USED)

Emergency door light, mounted above emergency door, is operative when "MASTER" switch is in "NITE" or "PARK" position. Light circuit is protected by Number 13 circuit breaker on control panel at left of driver and is shown on "Lighting System Wiring Diagram." A tell-tale light on driver's gauge and tell-tale panel is incorporated in circuit to warn driver when door is open.

DOME LIGHTS (SUBURBAN MODELS)

Dome lights are mounted on ceiling along center aisle. Lights are controlled by "MASTER" switch in conjunction with the "DOME" light switch on recessed switch panel at left of driver. Dome lights are protected by No. 9 circuit brakes on control panel at left of driver. Refer to "Lighting System Wiring Diagram" at back of this manual. Dome lights will light with the "MASTER" switch in either "OFF" or "NITE" position and "DOME" switch placed in "ON" position, or with "MASTER" switch in "PARK" position and "DOME" switch in either "NORMAL" or "ON" position. To replace bulbs, remove one screw and lower hinged lens.

READING LIGHTS (SUBURBAN MODELS)

Reading lights are mounted just below package racks. The reading cight circuit, which is also controlled by the "DOME" switch, is energized only when "MASTER" switch is in "NITE" or "PARK" position.Whenever reading light circuit is energized, individual reading light switches can be controlled by the passenger. Reading lights are protected by circuit breakers mounted on the Regulator and Blower Control panel. Reading light circuit is shown on "Lighting System Wiring Diagram" at back of this manual. Each light has one bulb and one switch. To replace bulb in light assembly, remove two screws attaching lens and retainer.

BAGGAGE COMPARTMENT LIGHTS (SUBURBAN MODELS)

Baggage compartment lights are controlled by individual switches as each door is opened and closed. Bulbs are exposed and are readily accessible for replacement.

FLUORESCENT LIGHTING SYSTEM (TRANSIT MODELS)

NOTE: Refer to figure 8 and observe the caution stickers that are shown, before any repair or checks are made on the fluorescent lighting system.

Dome lights and destination sign light are fluorescent tube lamps. All other lights on vehicle are conventional incandescent bulb or sealed-beam type units. Dome and destination sign lights are mounted in plastic sockets (fig. 9). Dome light sockets are mounted on a base plate which is attached to the ceiling. Wiring harness connections at sockets are made through connector plugs behind the base plate. Lights are ballasted by capacitors installed in the light socket at rear end of each dome light and at right end of destination sign light. Socket at other end of each light has a spring-loaded end plug which permits removal and installation of the light.

The power supply unit is mounted on an extruded aluminum heat sink in right front corner of coach on forward side of entrance door stepwell front trim panel or access panel. Refer to "Power Supply Unit" later in this section for test and repair procedures.

With "MASTER" switch in "NITE" position ("STAND-BY SIGN" switch on recessed panel at left of driver must be in "OFF" position), dome and destination sign lights are on, together with marker, tail, instrument, and other night time operating lights. Dome and destination sign lights only can be turned on by placing "DOME" switch on driver's control panel in "DOME" position, regardless of the position of the other switches.

PRECAUTIONS

The following precautions must be observed when operating or servicing the fluorescent lighting system. Failure to observe these precautions may result in damage to the power supply unit which will necessitate replacement of the unit.

DO NOT OPERATE POWER SUPPLY UNIT -

1. With all fluorescent lamps removed.
2. With high voltage leaks disconnected.
3. For periods in excess of one minute when troubleshooting faulty operation.
4. With loose connections in feed or ground circuit. Severe damage will result if the power supply unit is operated for prolonged periods of time with loose connections in the direct current feed junctions.
5. Do not attempt to operate additional loads or use commercial fluorescent lighting equipment on the power supply.

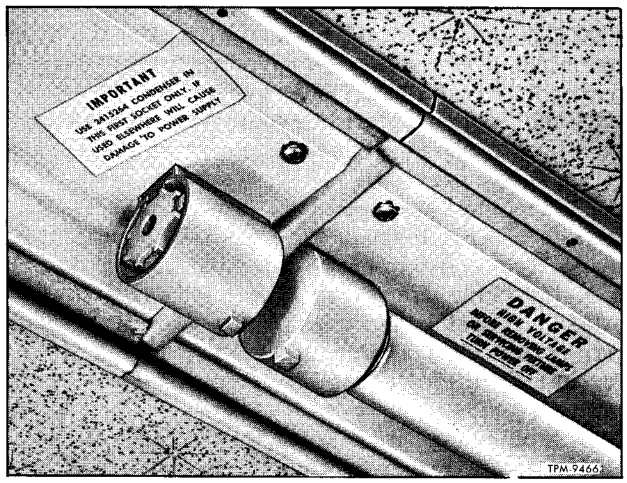


Figure 8—Dome Lamp Caution Stickers

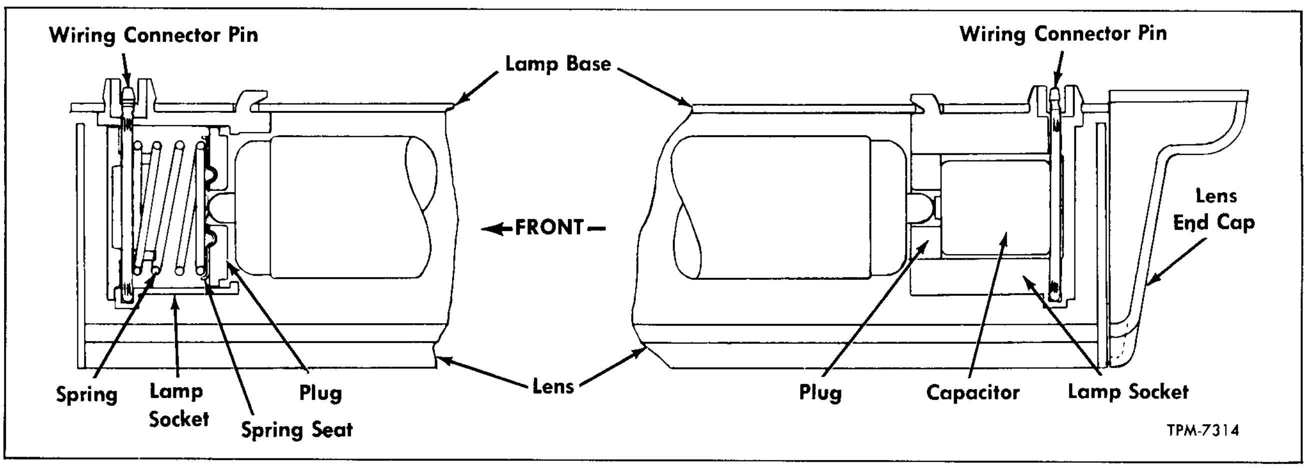


Figure 9—Dome Lamp Socket Installation

6. CAUTION: VOLTAGE ON OUTPUT SIDE OF POWER SUPPLY UNIT IS DANGEROUS. DO NOT TOUCH ANY HIGH VOLTAGE ELECTRICAL CONNECTIONS WITH HANDS WHEN THE LIGHTS ARE TURNED ON. EXCEPT WHEN NECESSARY TO HAVE LIGHTS ON FOR TROUBLESHOOTING, ALWAYS TURN LIGHTS OFF WHEN WORKING ON THE FLUORESCENT LIGHTING SYSTEM.

TROUBLESHOOTING

Faulty operation of the fluorescent lighting system will be evidenced by one of the following:

1. Reduced light output.
2. Lamps flash but do not stay lit.
3. Lamps fail to light.

Make a visual inspection for loose or broken electrical connections and make any necessary repairs.

Turn lights on by placing "MASTER" switch in "NITE" position (with "STAND-BY SIGN" switch "OFF"), then check for battery voltage at the input terminal of the power supply unit. If no voltage is present, turn "MASTER" switch off and place "DOME" switch on driver's control panel in "DOME" position. Again check for voltage at the power supply unit input terminal.

If voltage is obtained through the "DOME" switch but not through the "MASTER" switch, an open circuit exists between the "MASTER" switch and the dome lamp relay. Check for faulty destination sign relay and check No. 11 circuit breaker for open circuit. Destination sign relay and circuit breaker are located on apparatus panel at left of driver.

If no voltage is obtained with either switch on, refer to "Lighting System Wiring Diagram" and make a point-to-point check for circuit continuity to locate the open circuit.

If no trouble is indicated in the low voltage circuit and voltage is present at the power supply unit input terminal, the following procedures should locate the source of the trouble in the high voltage circuit.

1. Reduced Light Output. If there is a marked reduction in the illumination of the coach interior with engine running which cannot be corrected by tightening loose connections, the power supply unit should be tested and repaired as directed under "Power Supply Unit" later in this section. Continued use under this condition will seriously damage unit.

2. Lamps Flash But Do Not Stay Lit.

a. A shorted capacitor in one lamp will cause the system to overload. The lamp with the short-circuited capacitor will flash; the other lamps may or may not flash.

b. Turn lights off and remove all lamps that flashed.

c. Turn lights on; remaining lamps will light. One at a time, replace lamps which were removed. When the lamp which has shorted capacitor is installed, the system will again overload and that lamp will flash, and the capacitor for that lamp must be replaced.

CAUTION: Be sure to turn off lights before removing capacitor.

d. To replace the short-circuited capacitor, remove the end plug from the lamp socket. Install new capacitor with terminal toward open end of socket, install end plug in socket, then install lamp.

NOTE: The socket at the rear end of dome light nearest the destination sign uses 2415264 condenser. This condenser is used in this socket only; if used elsewhere it will cause damage to power supply. Refer to figure 8.

3. Lamps Fail to Light. With lights turned off, remove high voltage connections from bottom of supply unit by pulling wiring harness plugs out of sockets. With an ohmmeter, check each high voltage lead for grounds. Check for circuit continuity between the two high voltage leakds. Any continuity between the high voltage leads indicates a short-circuited wiring harness. If ohmmeter indicates no ground or short circuit, test and repair power supply unit as directed under "Power Supply Unit" later in this section.

DOME LAMP SOCKETS

Lamp sockets are mounted on a base plate which is attached to coach ceiling. To replace any socket, it is necessary to remove the lamp lens, remove the base plate attaching screws, and lower the base plate for access to the wiring harness connector and socket attaching screws.

To remove lens, remove retaining screws at one side of lens, swing lens down, and unhook bead at other side of lens from base extrusion. To install lens, hook beaded edge of lens into base extrusion, swing lens up, and install retaining screws.

Socket assembly at rear end of each dome lamp (right end of destination sign lamp) consists of the socket housing and contact pin assembly, ballast capacitor (condenser), and end plug (fig. 9).

Socket assembly at front end of each dome lamp (left end of destination sign lamp) consists of the socket housing and contact pin assembly, spring, contact plate, and end plug.

POWER SUPPLY UNIT

DESCRIPTION AND OPERATION

The power supply consists basically of two units interconnected to operate in parallel. Each individual unit incorporates a transformer, a pair

of power transistors, two silicon diodes, a resistor and a capacitor. The transistors act as electronic reversing switches operating alternately to direct the DC power from the battery through the transformer primary; first in one direction and then in the opposite direction. The primary current is magnetically induced into the high voltage output winding and simultaneously to the low voltage feed-back winding. The high voltage produced is 1000 volts at 8000 cps, and is used to power the fluorescent lights. The low voltage feed-back current provides switching energy for the transistors. The feed-back current is controlled by the silicon diodes, resistor and capacitor. An additional resistor is added from one transistor base (control element) to ground for the purpose of starting the transistor switching action when the power supply unit is initially placed in operation. Transformers are connected so that the respective primary and high voltage secondary windings are connected in parallel.

Figure 12 shows power supply unit circuitry with each major unit identified. Figure 13 shows corresponding items in actual location on assembly in respect to circuitry diagram (fig. 12).

POWER SUPPLY UNIT REPLACEMENT

On early coaches, power supply unit is mounted on forward side of entrance door stepwell front trim panel (fig. 10). On late coaches, power supply unit is mounted in the same location on a removable access panel (fig. 11).

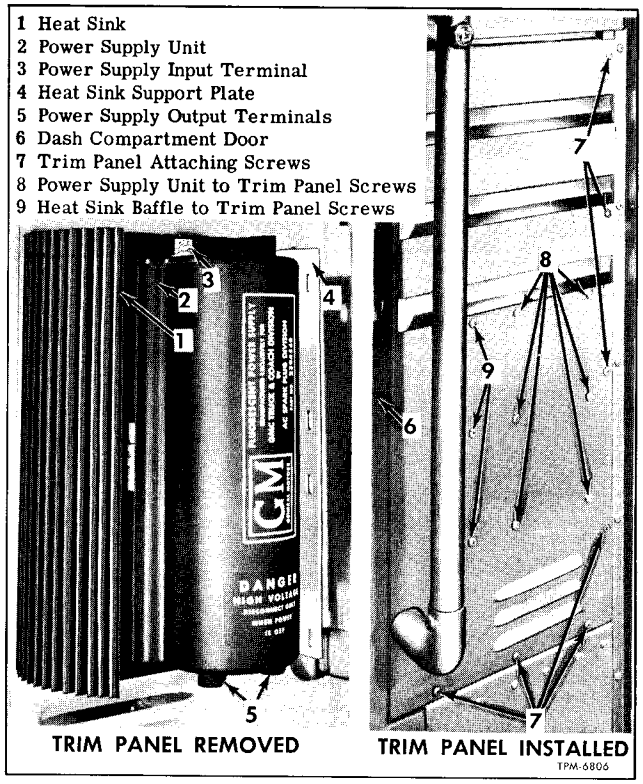


Figure 10—Power Supply Installed on Trim Panel (Early Models)

CAUTION: Before attempting to remove or install power supply unit, observe "PRECAUTIONS" previously in this section.

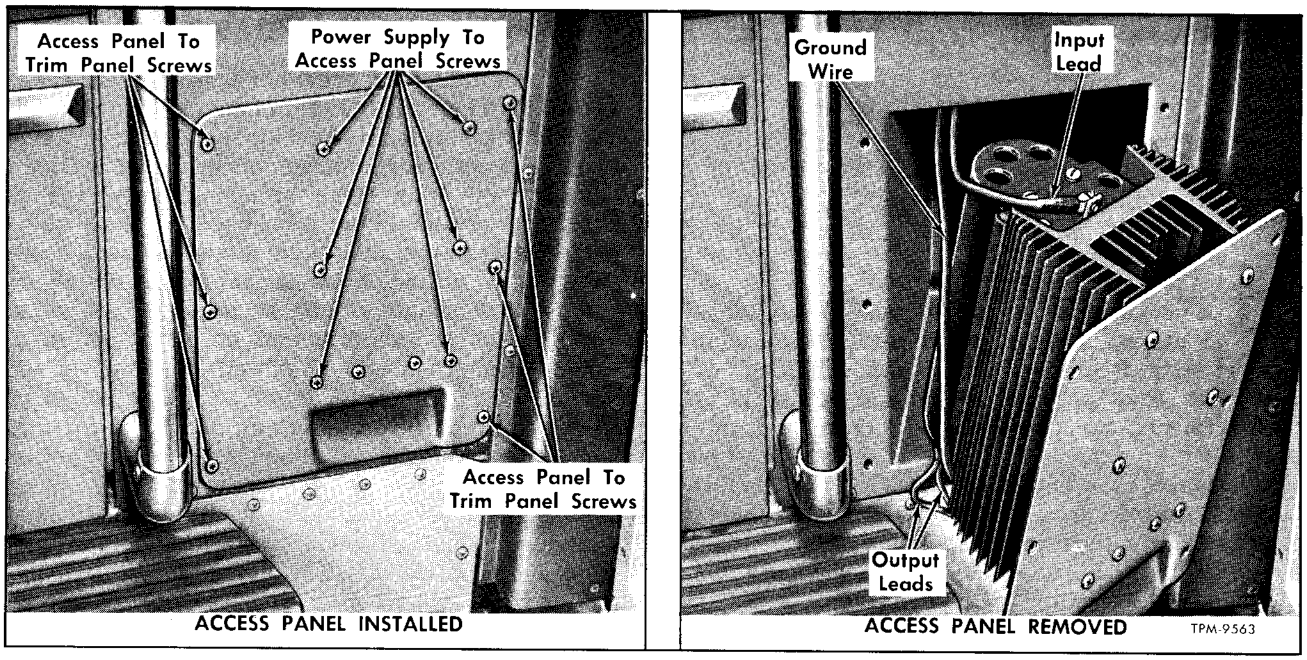
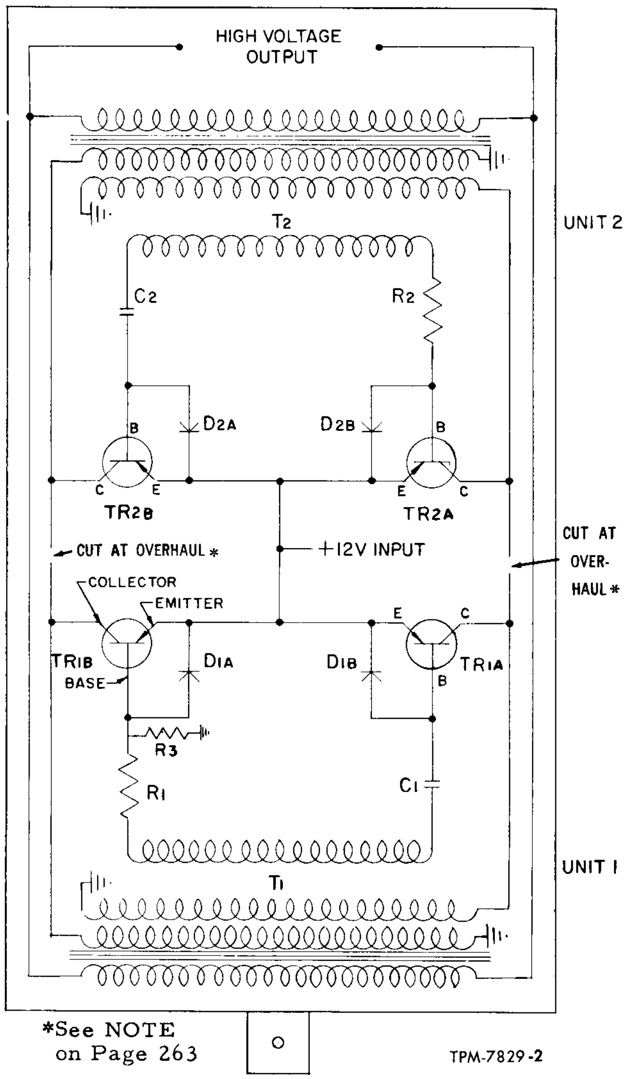


Figure 11—Power Supply Installed on Access Panel (Late Models)



*See NOTE on Page 263

Figure 12—Power Supply Unit Circuitry Diagram

REMOVAL

Without Access Panel (fig. 10)

1. Remove three screws attaching heat sink baffle to stepwell front trim panel and heat sink support plate. From inside dash compartment, remove two screws attaching bottom of baffle to compartment floor. Remove baffle from compartment.

2. Make sure both the "MASTER" switch and "DOME" switch are in "OFF" position. Disconnect input lead from input terminal at top of power supply unit, and pull two wiring harness lead plugs out of output terminal sockets at bottom of power supply unit. Remove nut and disconnect ground wire.

3. From inside the dash compartment, loosen four bolts attaching dash compartment door hinge and stepwell front trim panel to windshield ledge support channel. Remove four bolts attaching heat sink support plate to windshield ledge support channel.

4. Remove seven screws attaching stepwell front trim panel to dash compartment framing. Remove trim panel, support plate, heat sink, and power supply unit as an assembly.

5. Remove heat sink and power supply unit assembly and support plate from trim panel by removing six attaching screws and lock washers.

With Access Panel (Fig. 11)

1. Make sure both the "MASTER" switch and "DOME" switch are in "OFF" position.

2. Remove six screws attaching access panel to trim panel.

3. Swing access panel out, then disconnect ground wire, disconnect input lead from input terminal at top of power supply unit, and pull two wiring harness plugs out of output terminal sockets at bottom of power supply unit.

4. Remove access panel and power supply unit from opening.

5. Remove six screws attaching power supply unit to access panel.

INSTALLATION

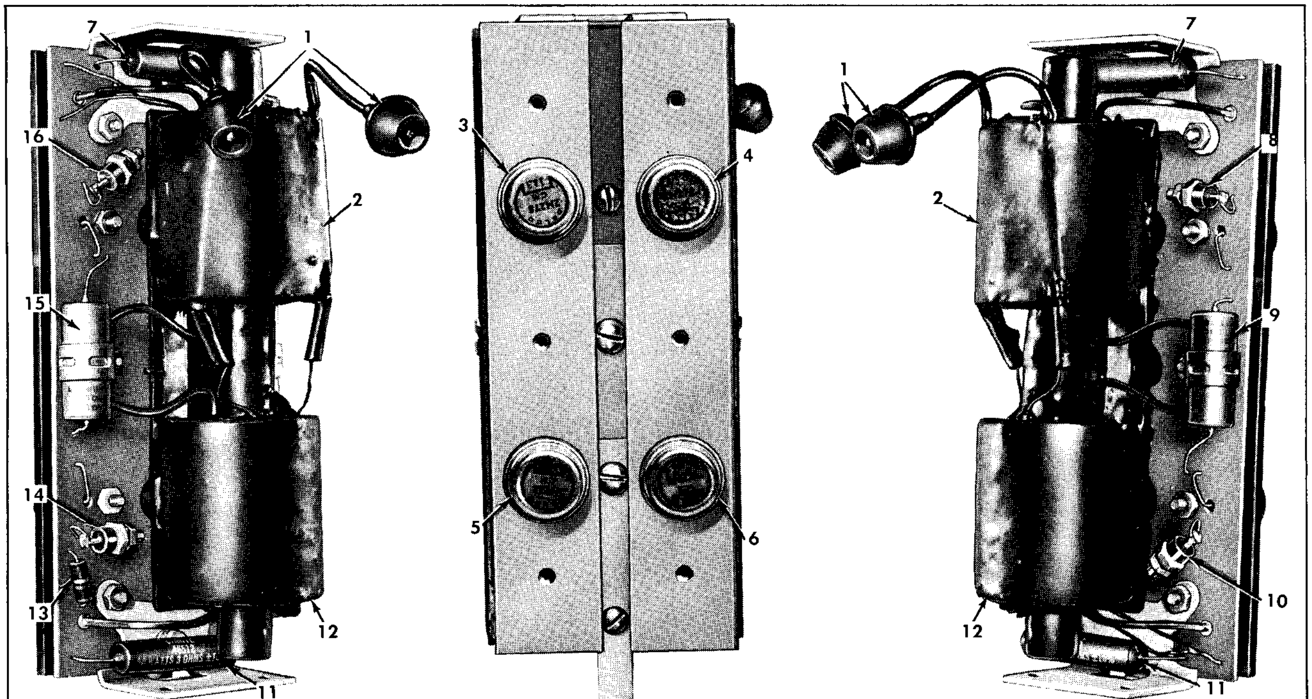
Without Access Panel (Fig. 10)

1. Install heat sink support plate and heat sink and power supply unit assembly on stepwell front trim panel. Flanged edge of support plate must be toward flanged side of trim panel. Attach heat sink and support to trim panel with six screws and lock washers.

2. Position trim panel assembly at dash compartment, inserting flange on inner edge of panel between dash compartment door hinge and windshield ledge support channel, with notches in flange engaging the four hinge attaching bolts. Install seven screws attaching trim panel to dash compartment framing, then tighten the four dash compartment door hinge bolts. Attach heat sink support to side of windshield ledge support channel, using four bolts, flat washers, lock washers, and nuts.

3. Make sure both the "MASTER" switch and "DOME" switch are in "OFF" position. Connect wiring harness leads to power supply unit output terminals by inserting plugs firmly into output terminal sockets at bottom of unit. Connect input lead to input terminal at top of power supply unit, tightening terminal screw firmly. Connect ground wire, and tighten nut firmly.

4. Position heat sink baffle in dash compartment. Attach baffle to dash compartment floor with two screws and to stepwell front trim panel with three screws.



1 Output Leads
2 Transformer (T2)
3 Transistor (TR2A)
4 Transistor (TR2B)
5 Transistor (TR1A)
6 Transistor (TR1B)
7 Resistor (R2)
8 Diode (D2B)
9 Condenser (C1)
10 Diode (D1B)
11 Resistor (R1)
12 Transformer (T1)
13 Resistor (R3)
14 Diode (D1A)
15 Condenser (C2)
16 Diode (D2A) TPM-7819-1

Figure 13—Power Supply Unit Components

With Access Panel (Fig. 11)

1. Install power supply unit on access panel and attach with six screws.
2. Position access panel and power supply unit at opening.
3. Make sure both the "MASTER" switch and "DOME" switch are in "OFF" position.
4. Connect wiring harness leads to power supply unit output terminals by inserting plugs firmly into output terminal sockets at bottom of unit. Connect input lead to input terminal at top of power supply unit, tightening terminal screw firmly. Connect ground wire, and tighten nut firmly.
5. Install access panel over opening in trim panel and attach with six screws. Tighten screws firmly.

DISASSEMBLY

1. After unit has been removed from mounting, place on a clean work bench.
2. Remove screws attaching plastic cover to power supply unit. Remove cover, unsnapping output terminal connector grommets from holes in cover.

NOTE: It is not necessary to remove heat sink from panel board unless component parts are to be replaced. If parts are to be replaced, remove six Allen head screws underneath heat sink and separate panel board from heat sink.

TROUBLESHOOTING

(Refer to Figure 14)

NOTE: When troubleshooting unit, use an ohmmeter having a 1-1/2 volt dry cell battery, such as a Simpson Model 240 Multimeter. Select scale that is applicable to check being made. The polarity of the leads must be observed to correctly determine a faulty component.

TRANSFORMERS (CHECK 1)

Connect ohmmeter as shown in check 1. Reading should be 1.1 to 1.5 ohms. If reading is below 1.1 to 1.5 ohms, transformer(s) is shorted. If a very high (infinite) reading is obtained, transformer(s) is open.

RESISTORS R1 AND R2 (CHECK 2)

Connect ohmmeter as shown in check 2 to resistors R1 and R2. A reading of 2.7 to 3.3 ohms should be obtained. If reading is above or below 2.7 to 3.3 ohms, resistor is defective.

TRANSISTORS TR1A, TR1B, TR2A, AND TR2B

CHECK 3: Before making ohmmeter checks as shown in "Check 3" of figure 14, unsolder or clip

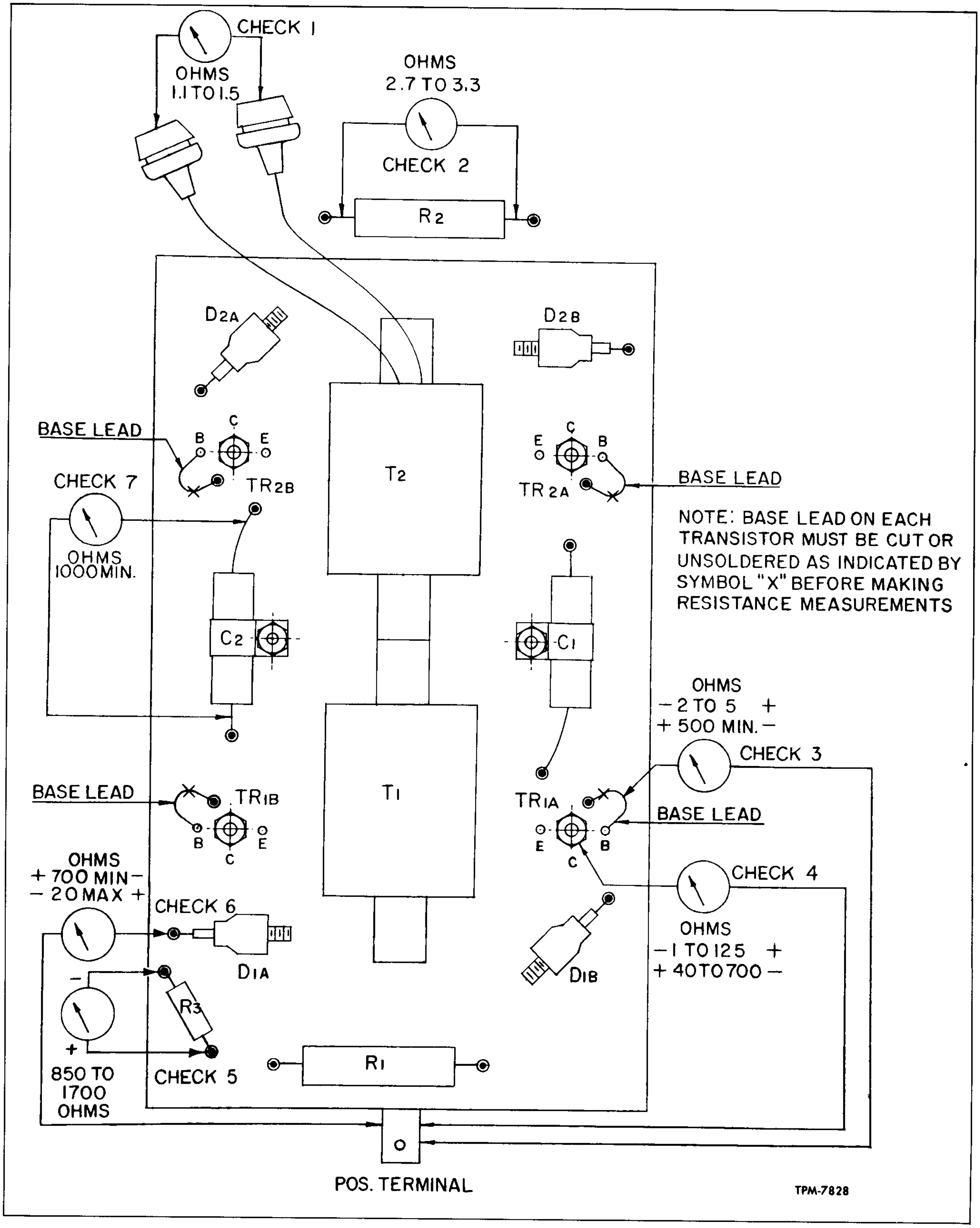


Figure 14—Power Supply Unit Ohmmeter Checks

base leads as shown. Make two checks at each unit, reversing the polarity of the leads for the second check. Make sure all transistors are checked. Ohmmeter readings for each polarity is shown in figure 14 above "Check 3." When checks are complete, secure base lead to transistor.

CHECK 4: Connect ohmmeter to each transistor as shown in "Check 4" of figure 14. Make two checks at each unit, reversing the polarity of the leads for the second check. Ohmmeter readings for each polarity are shown in figure 14 below "Check 4."

RESISTOR R3 (CHECK 5)

Connect ohmmeter as shown in "Check 5" to resistor R3. Make sure ohmmeter leads are correct in respect to polarity as shown. A varied reading of 850 to 1700 ohms should be obtained. If a very low or infinite reading is obtained, resistor is defective.

DIODES D1A, D1B, D2A, AND D2B (CHECK 6)

Connect ohmmeter to all diodes as shown in "Check 6" of figure 14. Make two checks at each unit, reversing the polarity of the leads for the second check. Ohmmeter readings for each polarity are shown in "Check 6" of figure 14. If readings do not agree with those in figure 14, diode is defective.

CONDENSERS C1 AND C2 (CHECK 7)

Connect ohmmeter to each condenser as shown in "Check 7" of figure 14. A minimum reading of 1000 ohms should be obtained. If reading is below 1000 ohms, condenser is shorted.

REPAIR

When replacing a component, use only radio type rosin core solder. Use only "60-40" solder, that is 60% tin and 40% lead. Never use additional fluxes or "non-corrosive" pastes.

A good, clean, well tinned soldering iron of 30-100 watts or the equivalent in a soldering gun is satisfactory. Care must be taken in soldering transistor leads and printed circuit boards. Use only enough heat to flow solder smoothly over the connection, too much heat will damage the transistors or will loosen the copper foil from the printed circuit boards.

When replacing transistors, refer to figure 15 for correct position of insulators and bushings. Make sure the mating surfaces of the finned aluminum and copper heat sink are very clean before transistor is installed. Apply several drops of silicon oil on the mating surfaces between the aluminum and copper heat sinks when reassembling.

Inspect transformers for defective lead-in wires and insulation. Repair or replace if found to be defective.

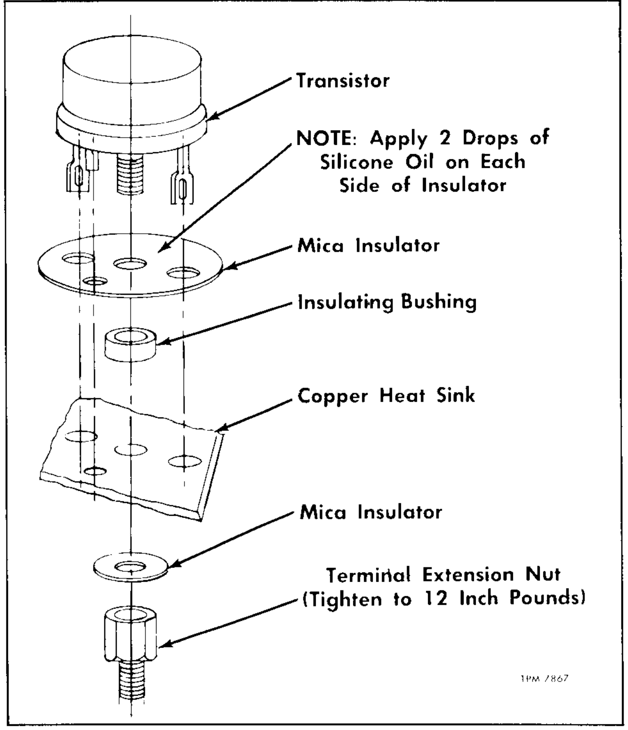


Figure 15—Installing Transistors In Power Supply Unit

NOTE: Whenever power supply unit is disassembled for testing or repair, disconnect leads between TR1B and TR2B and between TR1A and TR2A as indicated in figure 12. Disconnect is made by cutting a piece out of the printed circuit.

ASSEMBLY

1. If removed during "Disassembly," install heat sink to panel board, using six Allen head screws.
2. Position output terminal connector grommets in plastic cover. Position cover in proper position and install attaching screws.
3. Install in vehicle as explained previously under "Replacement."

POWER SUPPLY BENCH TEST

As it is not possible to measure output voltage directly or indirectly from the output terminal of the power supply unit, the following procedure should be observed when bench testing the fluorescent light power supply unit: (Refer to figure 16 for schematic diagram of electrical connections necessary for the following test.)

1. Attach a battery charger capable of supplying twenty amperes to one 12-volt battery.
2. Adjust battery charger to maintain a 14-volt output at the battery post.

LIGHTING SYSTEM

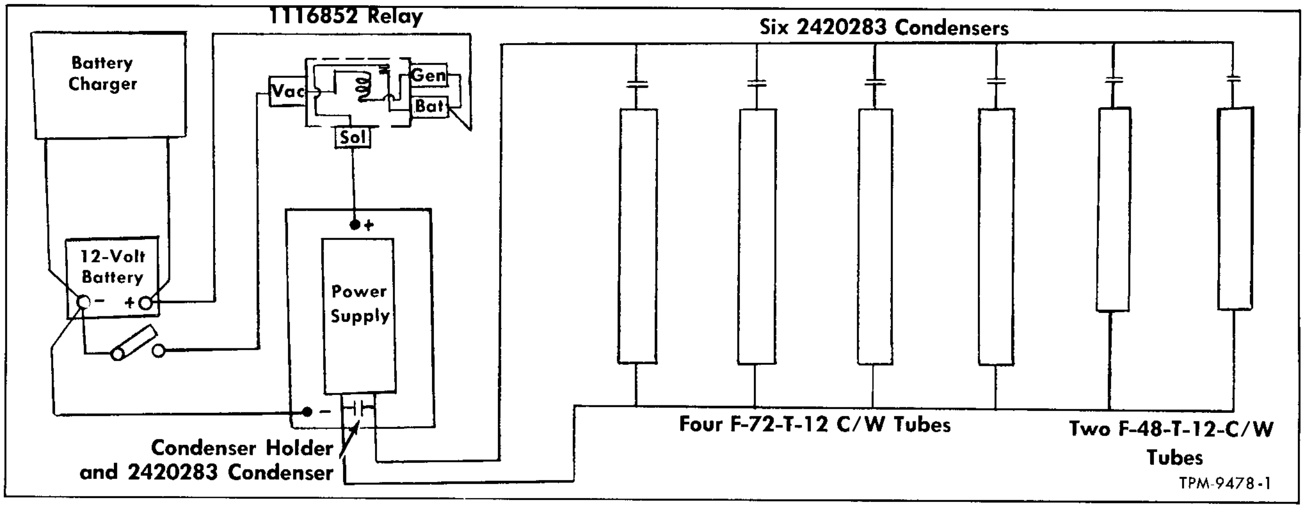


Figure 16—Schematic Diagram of Power Supply Unit Bench Test Hook-up

3. Attach eighty inches of fourteen gauge wire to the "POS" post of the battery.

4. Connect a relay to the eighty inches of wire at any point between the battery "POS" post and the "POS" post of the power supply. Refer to figure 16 for relay hook-up.

5. Connect a second length of fourteen gauge wire, eighty inches long, to the ground of the power supply unit. Attach the other end of this wire to the "NEG" post of the battery.

6. Wire the output side of the power panel to a bank of four Slimline fluorescent tubes F-72-T-12-c/w and two Slimline fluorescent tubes F-48-T-12-c/w. NOTE: The fluorescent tubes must be wired in parallel. Tubes must be of the same type as actually used in the coach to be tested and will require 12-lamp socket assemblies, seven condensers, and one conderser holder as used on the coach.

7. After mounting parts called out in step 6 on a board, the test can be made. Allow power panel to operate for at least one hour.

8. If the unit operates for one hour, it can be considered satisfactory; if unit fails to operate satisfactory, recheck resistance of all units as previously directed under "Troubleshooting," and replace defective parts.

LIGHT BULB DATA

Name	Qty.	Candlepower	Trade No.
Headlight Sealed-Beam Unit			
(Inside—Stamped No. 1)	2	37.5	4001
(Outside—Stamped No. 2)	2	37.5-50W	4002
Instrument Panel Lights	2	2	57
Tell-tale Lights	10	2	57
Rear License Plate Light	1	4	67
Corner Marker Lights	4	6	89
Destination Sign Standby Lights (Transit)	4	15	93
Door Step Lights	2	21	1141
Taillights	2	4	67
Front Directional Lights	2	21	1141
Stop and Rear Directional Lights	2	21	1141
Engine Compartment Lights	6	21	1141
Side Visual Lights	2	4	67
Dome Lamp (Transit Models)	4	Slimline (Cool-White)	72"-T12
Dome & Destination Sign (Transit Models)	2	Slimline (Cool-White)	48"-T12
Michigan Marker Lights	6	4	67
*Emergency Door Light	1	4	68
Driver's Light	1	15	93
Freon Receiver Tank Bulb	1	6	89
Rear Exit Door Light	1	6	89
Dome and Reading Lights (Suburban Models)	AR	21	1141
Destination Sign (Suburban Models)	5	15	93
Baggage Compartment (Suburban Models)	5	15	93

*Double Contact

Diesel Engine

Coach is powered by 6V-71 GM Diesel engine as standard equipment; however, the 8V-71 is available as special equipment. Engine, transmission, and radiator comprise a unit power plant which is supported on engine cradle assembly and installed transversely in engine compartment at rear of coach (figs. 1 and 2).

This section of manual covers description and maintenance of engine accessories which are not included in DIESEL ENGINE MAINTENANCE MANUAL or in other sections of this manual. Also included is the procedure for replacing the complete power plant and cradle assembly. Refer to ELECTRICAL SYSTEM (SEC. 7) for information on electrical units such as generator and starter.

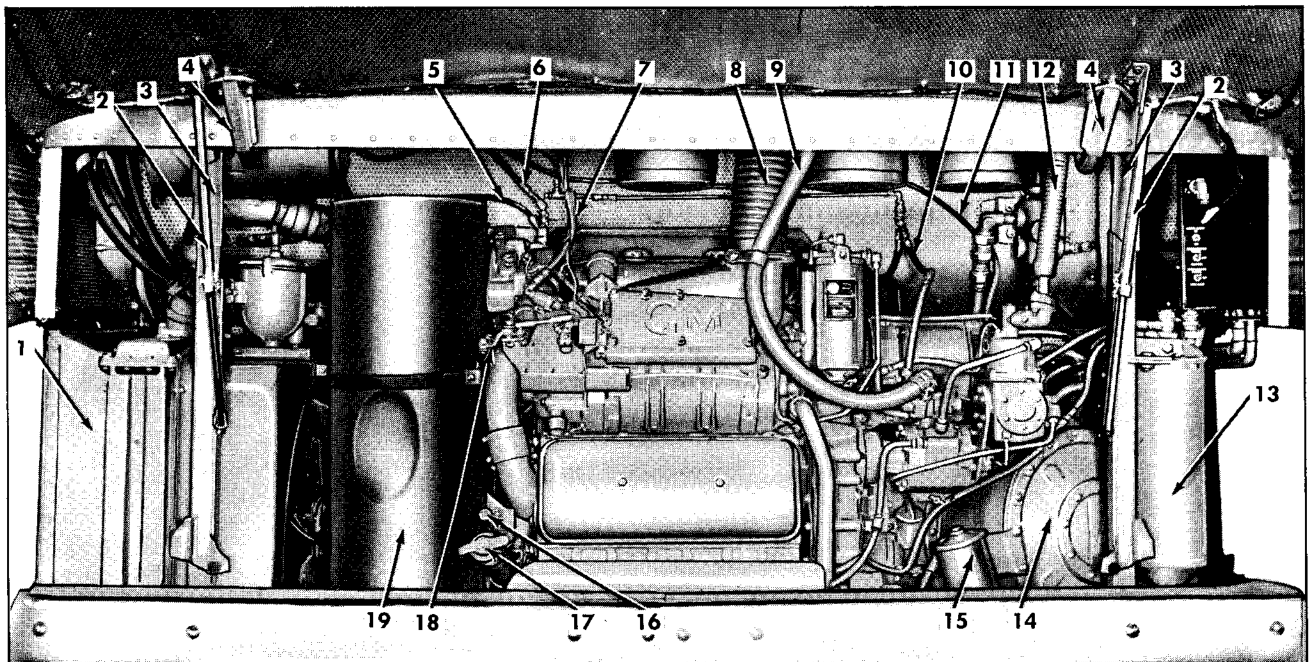
Maintenance of cooling system units is covered in COOLING SYSTEM (SEC. 6), while fuel system maintenance procedures are in FUEL SYSTEM (SEC. 12) in this manual. Engine general data is given at end of this section.

DIESEL ENGINE ACCESSORIES

Engine accessories described in following paragraphs are regular equipment and are not covered in current DIESEL ENGINE MAINTENANCE MANUAL or in other sections of this manual.

OIL PRESSURE GAUGE

An oil pressure gauge is installed in oil pressure sending manifold on engine compartment bulkhead (fig. 3) for convenience when working on engine. The registering gauge at driver's instrument panel is electric type interconnected with sending unit at oil pressure manifold in engine compartment. Electric oil gauge circuit is operative only when the "MASTER" switch is in "DAY" or "NITE" position. See "Alarm and Signal Wiring Diagram" at back of book.



1 Radiator	8 Blower Intake Hose	14 Transmission
2 Door Support	9 Air Compressor Intake Hose	15 Transmission Oil Filter
3 Engine Support Hanger	10 Air Compressor Governor Line	16 Engine Oil Dip Stick
4 Door Hinge	11 Oil Pressure Line	17 Engine Oil Filler
5 Deaeration Line	12 Air Compressor Discharge Line	18 Throttle Control
6 Vent Line	13 Engine Oil Filter	19 Muffler
7 Engine Stop Air Line		

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Figure 1—Power Plant Assembly Installed—6 Cylinder with Hydraulic Transmission

8

TEST

In case electric oil gauge fails to function or if it gives an apparent false reading, system may be checked as follows:

1. Disconnect wire from engine unit and connect a test lamp of not more than 2 C.P. between battery terminal of starter solenoid and body of the unit. If lamp fails to light, the unit is not grounded, and the threaded hole and the threads on the unit should be checked for metal to metal contact. If the lamp lights the unit can be considered grounded. (DO NOT USE A LAMP OF OVER 2 C.P.)

2. Remove the wire from the unit terminal and connect the test lamp between the unit terminal and the battery post on the starter solenoid. If lamp lights, start engine and observe if lamp changes intensity. A satisfactory unit will change the lamp intensity at different engine speeds. (Changes in oil pressure.)

3. Replace the wire and check wiring for open circuit between unit and gauge on instrument panel, referring to "Alarm and Signal Wiring Diagram."

4. If units and circuits pass above tests, replace the gauge and check for operation at various engine speeds.

5. Do not attempt repairing gauge or sending unit. When replacing sending unit do not use thread compound as this will prevent proper ground and cause faulty gauge reading.

LOW OIL PRESSURE SWITCH

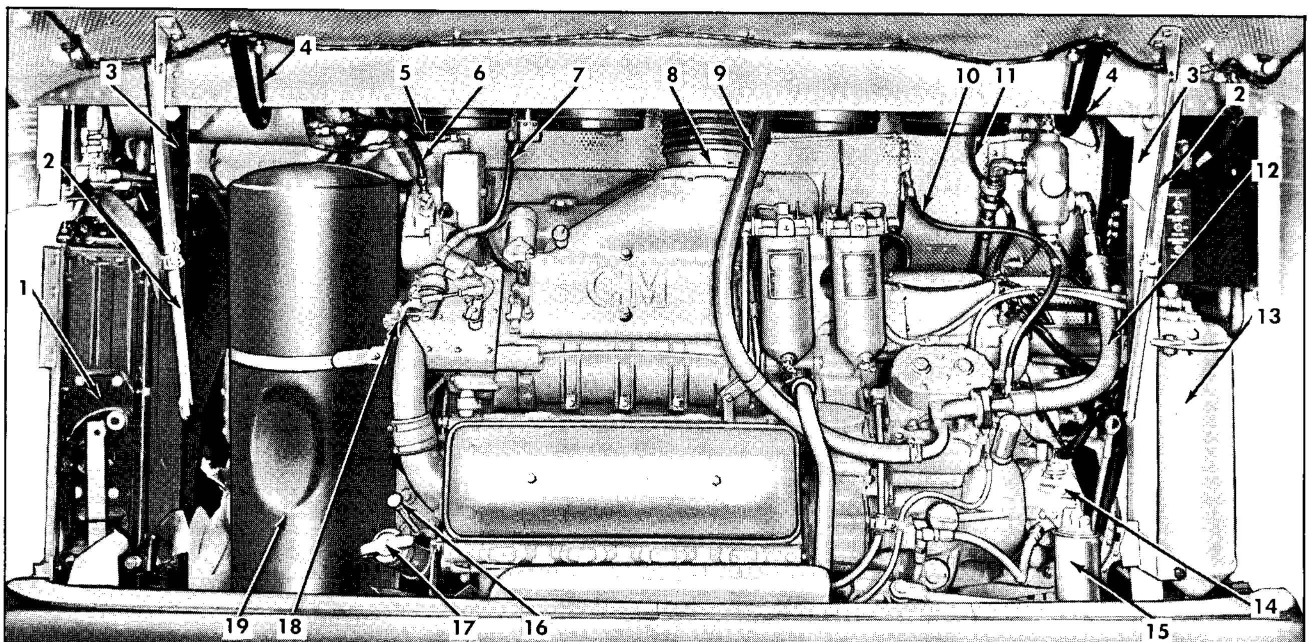
Low oil pressure electrical switch is installed in oil pressure sending manifold (fig. 3), which is mounted on engine compartment bulkhead. Manifold is connected with engine oiling system by a flexible tube.

When engine is running, the oil pressure acts upon a diaphragm to hold a pair of switch contacts open. However, if pressure should drop below 3 to 4 pounds, points will close completing circuit. When points close, tell-tale alarm buzzer sounds, and low oil tell-tale light illuminates. Whenever alarm buzzer sounds or low oil tell-tale lights, stop engine immediately and correct cause of low pressure.

CIRCUIT TEST

Low oil pressure indicating system is interconnected with control switch so that system is inoperative when control switch is off.

With "MASTER" switch in "DAY" or "NITE"



1 Radiator
2 Door Support
3 Engine Support Hanger
4 Door Hinge
5 Deaeration Line
6 Vent Line
7 Engine Stop Air Line
8 Blower Intake Hose
9 Air Compressor Intake Hose
10 Air Compressor Governor Line
11 Oil Pressure Line
12 Air Compressor Discharge Line
13 Engine Oil Filter
14 Transmission
15 Transmission Oil Filter
16 Engine Oil Dip Stick
17 Engine Oil Filler
18 Throttle Control
19 Muffler

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Figure 2—Power Plant Assembly Installed—8 Cylinder with Mechanical Transmission

position, and engine not running, low oil pressure tell-tale light should be illuminated and buzzer should sound. If buzzer sounds and light does not illuminate, replace bulb. If light is illuminated and buzzer does not sound, check the alarm buzzer.

If light fails to illuminate and buzzer fails to sound with master control switch turned on, momentarily connect the two wire terminals at pressure switch. Failure of tell-tale lights or buzzer to sound indicates that the circuit to these units is at fault. Refer to "Alarm and Signal Wiring Diagram" in back of manual for electrical circuit.

SOLENOIDS

Emergency stop solenoid assembly is installed at engine blower housing (fig. 4) and releases a choke valve to shut off air and stop engine in case engine cannot be stopped by normal means.

For normal use to stop engine, a solenoid valve (fig. 6) on bulkhead in engine compartment is used to admit air pressure to air cylinder which actuates lever on governor housing and moves engine injectors to no-fuel position. This mechanism operates automatically when master control switch is turned to "OFF" position.

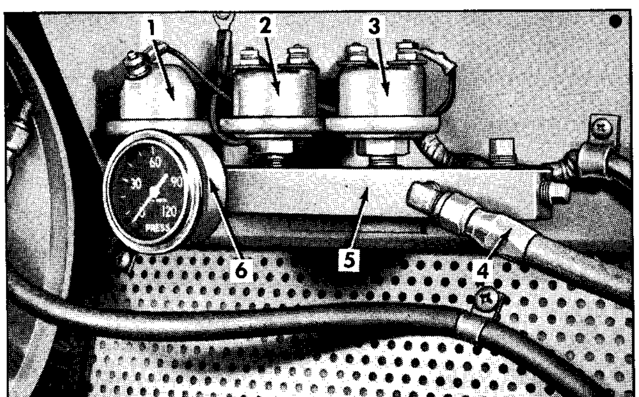
EMERGENCY STOP SOLENOID

Key numbers in text refer to figure 5.

Solenoid assembly components can be replaced as necessary when repairing the assembly.

Disassembly

1. To remove solenoid assembly from engine, wires must be disconnected from terminal and



1 Oil Pressure Gauge Sending Unit
2 Low Oil Tell-tale Sending Unit
3 Air Conditioning Oil Pressure Sending Unit
4 Oil Pressure Line
5 Oil Pressure Manifold
6 Oil Pressure Gauge
TPM-9352

Figure 3—Oil Pressure Gauges and Manifold—6 Cyl. Shown

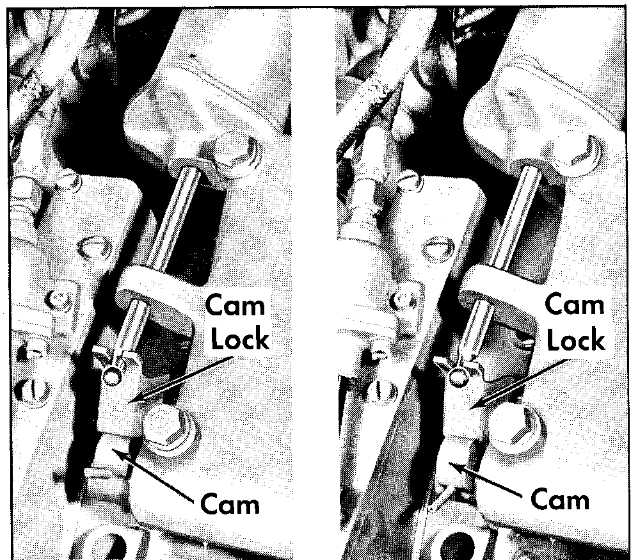


Figure 4—Emergency Stop Mechanism at Blower Housing

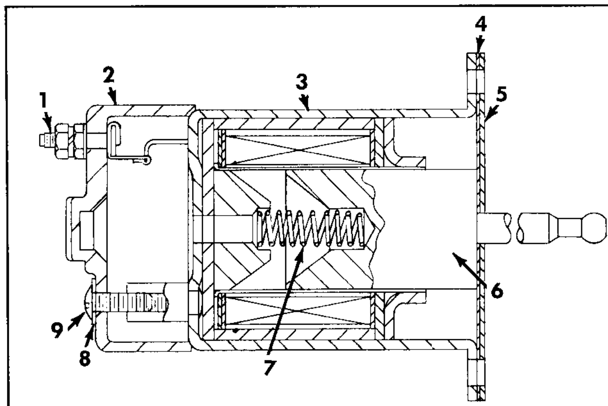
cam lock must be removed. Remove two mounting bolts holding solenoid assembly to blower housing.

2. Bend tangs on case (3) to permit removal of plate (5). Remove plate and gasket (5 and 4). Remove plunger and rod assembly (6) from case and coil assembly (3). Remove spring (7).

3. Remove screw (9) and washer (8) to permit inspection of coil wire attached to terminal (1).

Assembly

1. Be sure coil wire is securely attached to lug on terminal (1), then install cover (2) on case



1 Wire Terminal
2 Cover
3 Case and Coil Assy.
4 Gasket
5 Plate
6 Plunger and Rod Assy.
7 Plunger Spring
8 Washer
9 Cover Screw
TPM-7065

Figure 5—Emergency Stop Solenoid

and coil assembly (3), and attach with two screws (9) and washers (8).

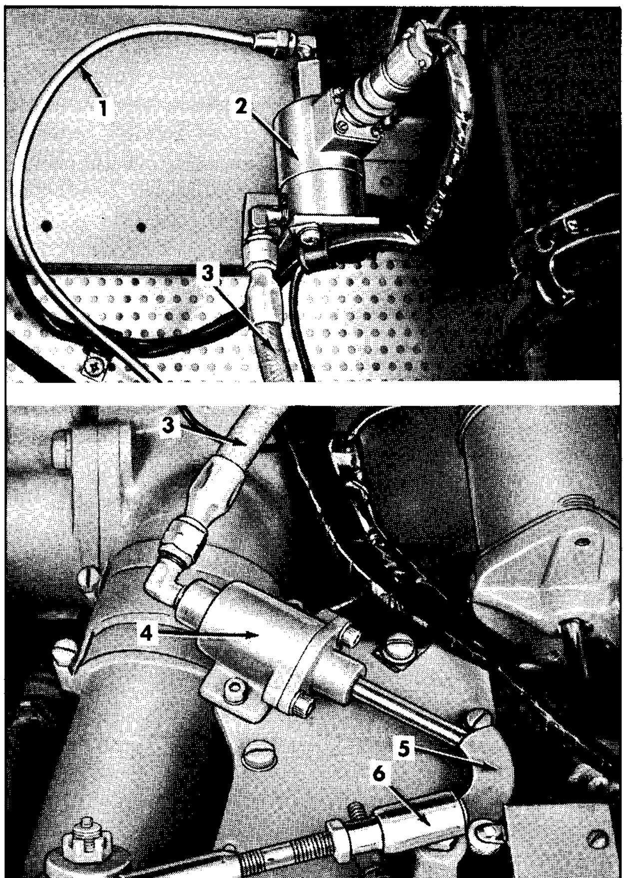
2. Place spring (7) in counterbore in plunger, then insert plunger into place in case and coil assembly. Slide plate (5) with gasket (4) on solenoid rod and bend tangs on case to hold plate (5) in place.

3. Insert plunger rod through guide on blower housing, and install two mounting bolts. Engage cam lock with plunger rod and bolt lock to blower housing. Attach wire to terminal (1). Solenoid and mechanism is installed as illustrated in figure 4.

NOTE: Cam (fig. 4) must be set in "run position" before engine can be started.

ENGINE STOP SOLENOID VALVE

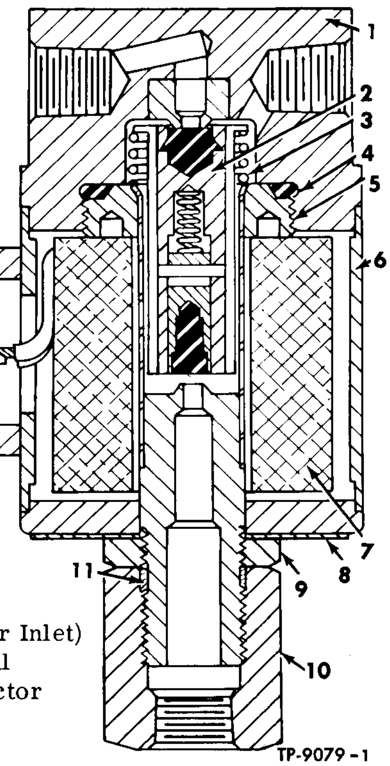
Solenoid valve shown in figure 7 can be disassembled for cleaning and inspection. Plunger, spring, and seals are available for service replacement.



1 Air Pressure Line
2 Engine Stop Solenoid
3 To Engine Stop Cylinder
4 Engine Stop Cylinder
5 Governor Stop Lever
6 Throttle Link

TPM-9401

Figure 6—Engine Stop Solenoid and Air Cylinder Installation



1 Valve Body
2 Plunger Assy.
3 Spring
4 Sleeve Seal
5 Sleeve Assy.
6 Housing
7 Coil
8 Name Plate
9 Sleeve Nut
10 Connector (Air Inlet)
11 Connector Seal
12 Wiring Connector

Figure 7—Engine Stop Solenoid Valve

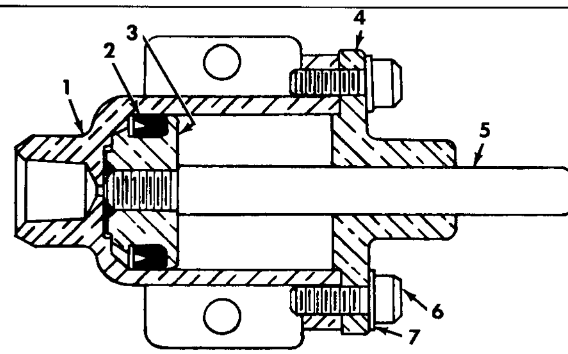
Disassembly

1. Remove threaded connector (10) and seal (11) from bottom of valve assembly, then remove thin nut (9) which holds housing and coil assembly to sleeve assembly (5).

2. Remove housing and coil assembly by sliding off lower end of sleeve assembly.

3. Using spanner wrench remove sleeve, plunger, and spring (5, 2 and 3) from valve body (1).

4. Separate plunger and spring from sleeve and remove seal (4) from valve body.



1 Cylinder
2 Piston Cup
3 Piston
4 Cylinder Cap
5 Piston Rod
6 Cap Screw
7 Lock Washer

TPM-8739

Figure 8—Engine Stop Air Cylinder

NOTE: Seals (4 and 11) should be discarded and new seals should be obtained for use when assembling valve.

Assembly

Examine valve seats and mating surfaces and check condition of spring. Obtain new parts as required and follow directions below to assemble.

1. Assemble spring (3) on plunger (2) then insert plunger into sleeve assembly (5).
2. Place new seal (4) in valve body then screw sleeve into body using spanner wrench.
3. Assemble housing and coil assembly over sleeve, then install name plate (8) and sleeve nut (9).
4. Place new seal (11) in groove in sleeve, then install connector (10) and tighten while holding nut (9).

CAUTION: Overtightening nut (9), will put excessive stress on sleeve; tighten nut only as necessary to seat parts solidly.

ENGINE SHUT-OFF AIR CYLINDER

Engine shut-off air cylinder (fig. 8) is mounted on engine governor cover with piston rod aligned with shut-off lever on governor shaft (fig. 4). When "MASTER" control switch is turned to "OFF" position, the engine stop solenoid valve on engine compartment bulkhead panel is de-energized and spring moves valve plunger to close exhaust passage and open air inlet passage in valve. With air pressure applied to shut-off air cylinder the piston pushes rod out against governor lever and moves engine injector racks to no-fuel position, thereby stopping engine.

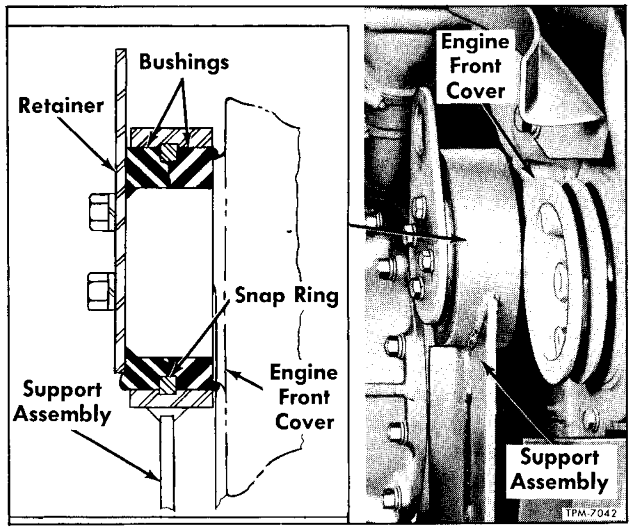


Figure 9—Engine Front Mounting

AIR CYLINDER REPAIR

Disassembly

1. Disconnect air line from air cylinder.
2. Remove two socket-head bolts which mount cylinder on governor cover, then remove air cylinder.
3. Remove two screws and lock washers (6 and 7) which secure cap (4) on cylinder (1). Remove cap (4) from piston rod.
4. Pull piston and rod assembly out of cylinder.
5. Clean and inspect components.

Assembly

1. Lubricate piston cup (2) and bore in cylinder (1).

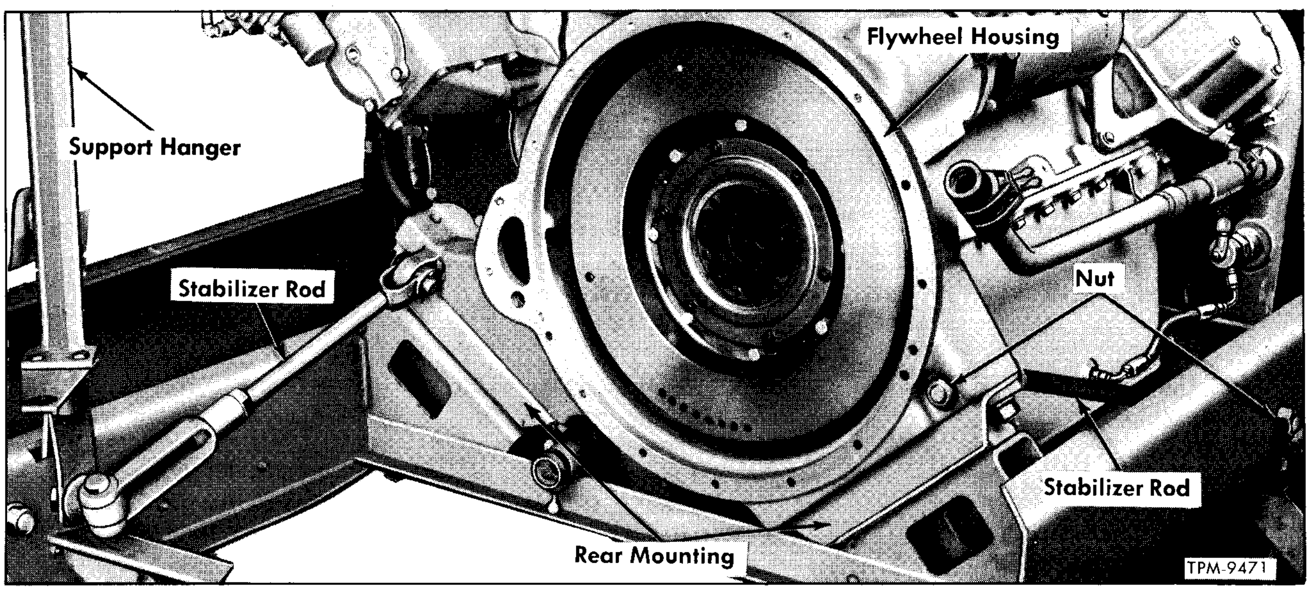


Figure 10—Engine Mounting and Stabilizer Rods—6 Cylinder Shown

2. Insert piston and rod assembly into cylinder bore using care to prevent damage to piston cup (2).

3. Install cap (4) on cylinder. Use lock washers (7) under heads of cap screws (6) and tighten screws to secure cap (4) on cylinder (1).

4. Install cylinder assembly on governor cover, and connect air line to cylinder.

ENGINE MOUNTING AND REPLACEMENT

Engine is supported by three cushion type mountings. Front of engine is mounted on two round rubber bushings and a support (fig. 9), while two flat rubber mountings are used at rear (fig. 10). Transmission is bolted to engine and the complete power plant including radiator (6-cylinder only), exhaust system, and rear bumper is supported on cradle. Two stabilizer rods (fig. 10) anchor the engine in position on cradle.

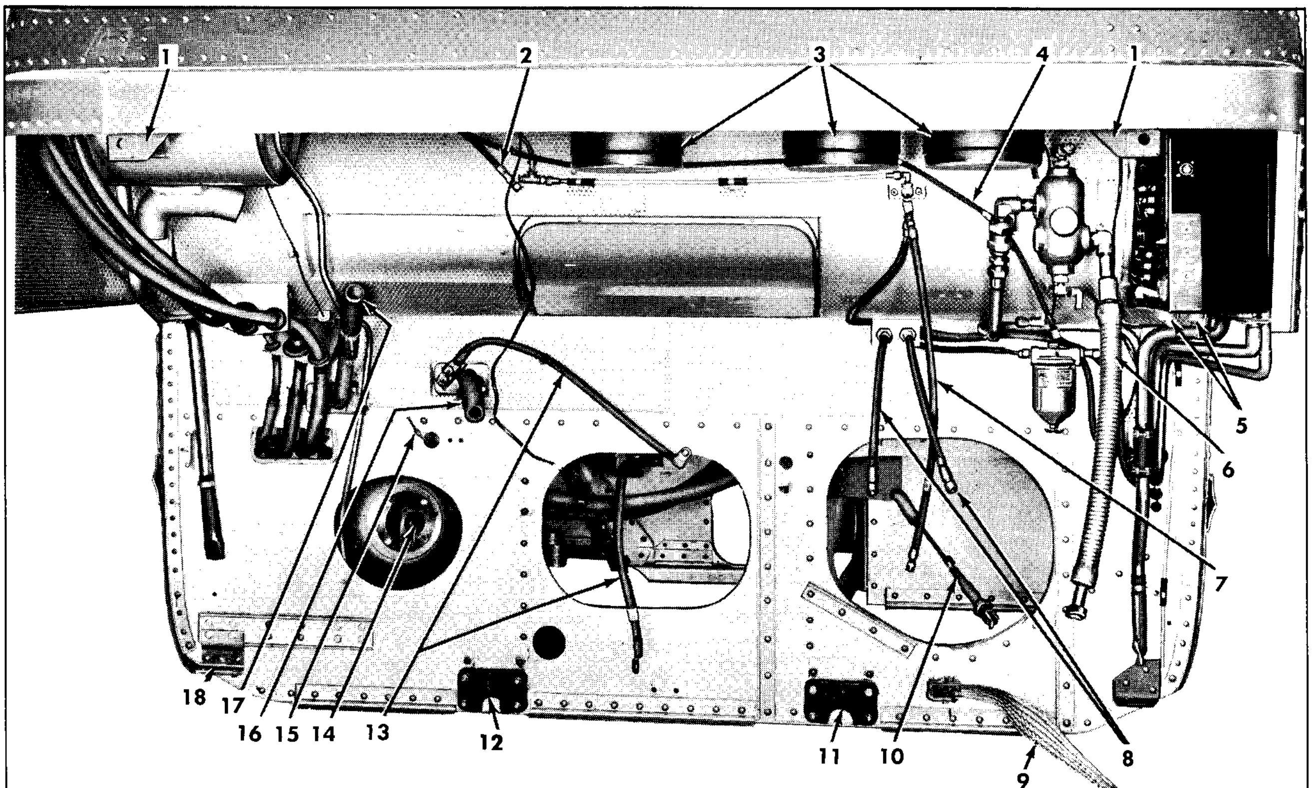
Brackets (figs. 11 and 12) at lower edge of bulkhead support the front side of cradle, while rear side is supported by two tube and plate assemblies suspended from support beam at rear of coach body. Instructions which follow describe method of replacing the complete power plant assembly. A special dolly must be used to support the power plant at cradle, and provide a means for moving the assembly out of engine compartment. Refer to figure 11 and 12 for location of various disconnect points in replacing power plant.

POWER PLANT REMOVAL

Key numbers in text refer to figures 11 and 12 unless otherwise indicated.

1. Remove dust shields below power plant, and drain cooling system, referring to COOLING SYSTEM (SEC. 6) for draining procedure.

NOTE: Before proceeding with removal operations, disconnect cables from battery terminals



1 Engine Support Hanger Bracket
2 Vent Line
3 Air Cleaners
4 Oil Pressure Line
5 Wiring Connectors
6 Air Compressor Discharge Line
7 Air Compressor Governor Line
8 Fuel Lines
9 Ground Strap
10 Transmission Control
11 Cradle Bracket - R.H.
12 Cradle Bracket - L.H.
13 Battery to Starter Cables
14 Air Conditioning Drive
15 Accelerator Cable Tube
16 Heater Return Line
17 Heater Supply Line
18 Radiator Support Bracket

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Figure 11—Engine Compartment Disconnect Points—6 Cylinder

and exhaust air from air system.

2. Raise radiator closure door and closure door at right side of engine compartment.

3. Remove engine compartment rear door by detaching door supports from cradle support tubes and removing hinge to body bolts also disconnect light wiring.

4. Remove muffler (fig. 1) to provide access to hose clamps and heater lines.

5. Disconnect propeller shaft and transmission control as directed in respective sections of this manual. Disconnect ground strap (9).

6. Working below coach, disconnect cables (13) from starter or coach body.

7. At right-hand support hanger and engine oil filter (fig. 13), disconnect oil lines and remove filter bracket bolts. Remove filter.

8. Disconnect wiring and cable from bottom of electrical apparatus box, also disconnect wires from switch at governor cover on coaches with hydraulic transmissions.

9. Disconnect air compressor discharge line (7), and compressor governor line (5).

10. Disconnect fuel lines (6) at junction bracket on engine.

11. Disconnect blower air intake hose, also air compressor air intake hose.

12. Disconnect air line from engine shut-off air cylinder.

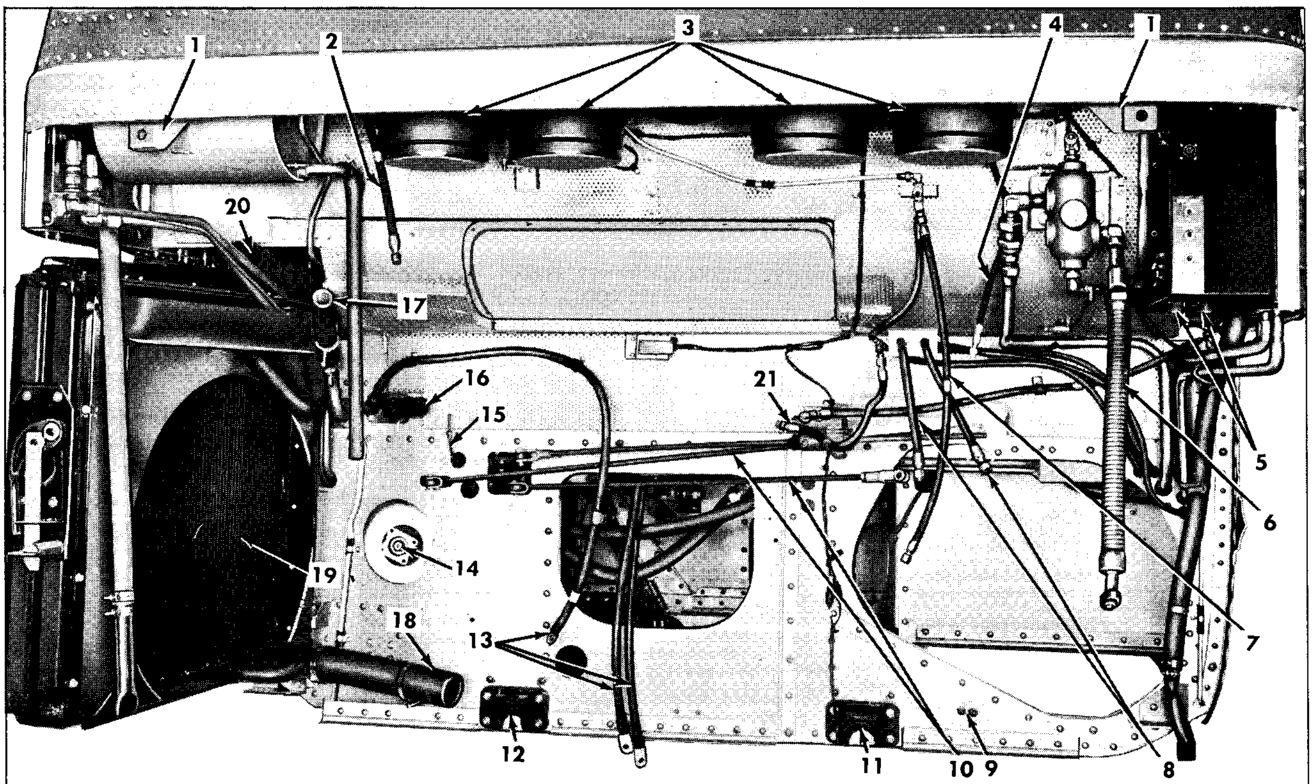
13. Disconnect water filter (when used) and cooling system vent line (13).

14. Disconnect water hoses from engine to radiator (8-cyl.) tank pipe and loosen heater line hose clamps at (2 and 14).

15. Disconnect accelerator control cable from engine at governor.

16. Loosen hose (18) at connector on top of radiator.

17. On 6-cylinder engine vehicles only, remove bolts from radiator lower support member



1 Engine Support Hanger Bracket
2 Vent Line
3 Air Cleaners
4 Oil Pressure Line
5 Wiring Connectors
6 Air Compressor Discharge Line
7 Air Compressor Governor Line
8 Fuel Lines
9 Ground Strap Terminal
10 Transmission Control Rods
11 Cradle Bracket - R.H.
12 Cradle Bracket - L.H.
13 Battery to Starter Cables
14 Air Conditioning Drive
15 Accelerator Cable Tube
16 Heater Return Line
17 Heater Supply Line
18 Radiator Outlet Hose
19 Radiator
20 Radiator Inlet Hose

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Figure 12—Engine Compartment Disconnect Points—8 Cylinder

bracket (16, fig. 11) and bolt and rubber mountings at radiator upper support.

18. Disconnect oil pressure manifold to engine oil line (4) at engine.

19. Remove right brace member from bracket (8) and from cradle rear member.

20. On mechanical transmission and clutch equipped coaches, disconnect transmission and clutch control rods (10, fig. 12) as directed in respective sections of this manual.

SAFETY CAUTION

Before proceeding with step 22 below, block coach body securely. When adjusting dolly to take weight of power plant, the coach body may be inadvertantly raised just enough to cause height control valves to exhaust, in which case entire weight of rear end of coach will be placed on dolly.

21. Position engine dolly under cradle and adjust to take weight off cradle hangers, then remove bolts from hanger bracket (1), then remove bolts from cradle brackets (11 and 12). Move power plant away from engine compartment slowly, meanwhile checking as necessary to see that all lines, wiring, and controls are disconnected.

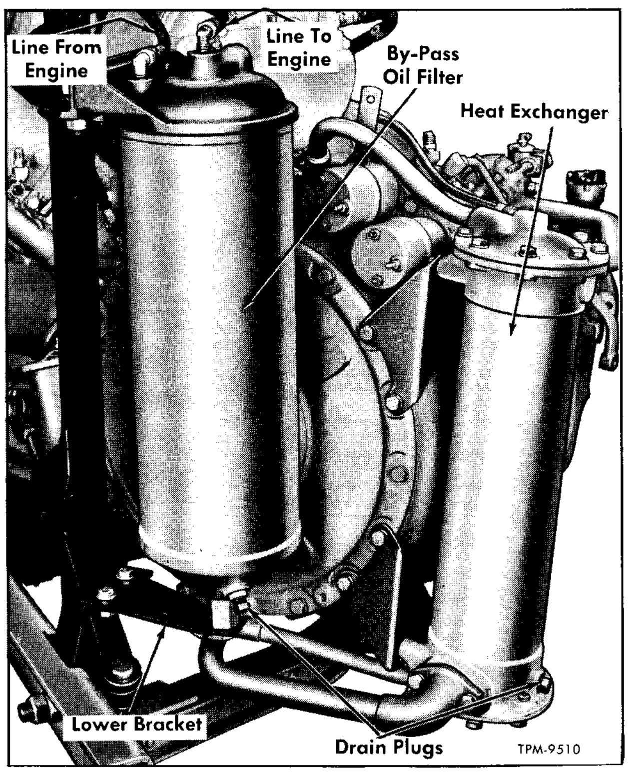


Figure 13—Engine Oil Filter and Transmission Heat Exchanger

22. Radiator and shroud assembly, and transmission assembly may be removed by following the pertinent instructions in COOLING SYSTEM (SEC. 6) and HYDRAULIC DRIVE TRANSMISSION MANUAL. Diesel engine may be lifted off cradle using lifting brackets provided at cylinder head.

Refer to DIESEL ENGINE MAINTENANCE MANUAL for repair information covering fluid fan drive mechanism.

ENGINE CRADLE AND MOUNTING INSPECTION

1. Inspect cradle members and engine front support members for wear and possible fractures. Repair as necessary.

2. Check condition of bulkhead brackets and bolts. Replace as necessary.

ENGINE MOUNTINGS

1. Inspect engine front mounting bushings (fig. 9). If bushings are deteriorated or damaged, replace bushings.

2. Inspect engine rear mounting assemblies and engine stabilizer rods (fig. 10). If mountings are oil-soaked or show evidence of failure, replace mountings.

INSTALLING POWER PLANT

Key numbers in text refer to figures 11 and 12 unless otherwise indicated.

Make necessary repairs to exhaust system units before installing power plant. Fan, radiator assembly, and transmission should be assembled to engine, since attaching parts are readily accessible with power plant removal. Refer to applicable section in this manual for details and procedure for installing engine accessories.

The steps listed below should be followed in the order given to install power plant.

1. Move power plant assembly into position, with cradle engaging brackets (11 and 12). Install bolts with nuts at bottom (fig. 14).

2. Install support hangers and connect at brackets (1). Tighten all bolts including those at bulkhead brackets firmly.

3. Remove dolly from cradle.

4. On 6-cylinder engines only, connect radiator support member at bracket (16, fig. 11), and install radiator mounting parts at upper support, also tighten hose clamps at radiator connection on surge tank.

5. Connect heater lines (12 and 14) and install engine thermostat housing to surge tank pipe and hose. Heat shield must be in place to shield muffler heat from hose at right-hand end of pipe.

6. Connect oil pressure line (4) at engine, and connect air line between solenoid valve and shutoff air cylinder on engine governor.

7. Connect wiring to bottom of apparatus box in engine compartment, also connect wiring at switch on governor housing.

8. Connect and adjust accelerator control. Refer to FUEL SYSTEM (SEC. 12) for instructions.

9. Install air intake hose at air cleaner manifold, also connect air compressor intake hose.

10. Connect water filter lines and cooling system vent line (3).

11. Connect fuel lines (6) at junction bracket on engine.

12. Install oil filter assembly at right support hanger and connect lines (fig. 13).

13. Connect wiring at bottom of electrical apparatus box.

14. Install air compressor discharge line (7) and compressor governor line (5).

15. Referring to respective sections of this manual, connect propeller shaft and transmission control.

16. Reconnect drive to engine as directed in AIR CONDITIONING (SEC. 26) of this manual.

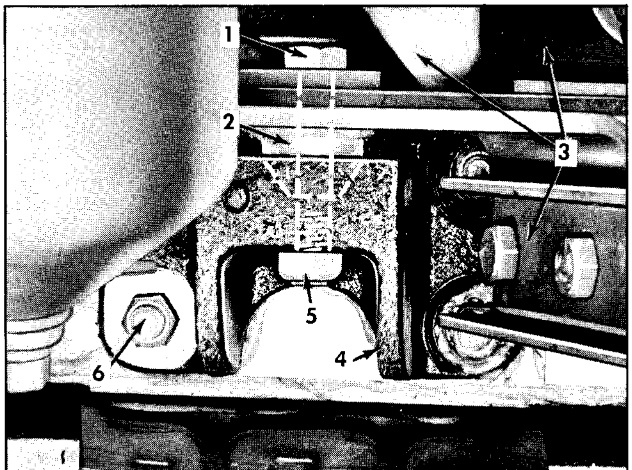
17. On vehicles with mechanical transmission and clutch install control rods and readjust as necessary as directed in respective sections of this manual.

18. Connect cables (13) at starter and connect ground strap (27).

19. Install cradle brace member and baffles bolting member to bracket and cradle.

20. Install air cleaner to blower intake hose; also, install air compressor air intake hose.

21. Install muffler (fig. 1).



1 Bolt Head
2 Cradle Locating Boss
3 Cradle Members
4 Bulkhead Bracket (L.H.)
5 Self-Locking Nut
6 Bracket to Bulkhead Bolts

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Figure 14—Construction at L.H. Cradle Bracket at Bulkhead

22. Install compartment rear door and prop in open position.

23. Refer to COOLING SYSTEM (SEC. 6) and fill system as instructed.

24. Install dust pans below power plant.

25. Connect battery cables and start engine. Check for oil and water leaks.

26. Close right, left, and rear engine compartment doors.

SPECIFICATIONS

ENGINE	
Model-6 Cyl.	6V-71
Model-8 Cyl.	8V-71
Bore	4¼″
Stroke	5″
Displacement (Cu. In.)(6V)	425.6
Displacement (Cu. In.)(8V)	567.5
Engine Rotation	Counterclockwise
Firing Order 6V-71	1L - 1R - 2L - 2R - 3L - 3R
Firing Order 8V-71	1L - 1R - 2L - 2R - 4L - 4R - 3L - 3R
Engine Governed Speed (No Load)	2150 RPM
Low Oil Pressure Switch	
Make	AC
Type	F-1
Contacts Break (Lbs. Pressure)	2-3
Oil Pressure Gauge on Instrument Panel	
Make	AC
Type	Electric
Gauge Unit No.	1509089
Sending Unit No.	1506502
Voltage	12
Range	0-120
Oil Pressure Switch	
Make	AC
Type	F
Emergency Stop Solenoid	
Make	Delco-Remy Division
Model	1114404
Voltage	12
Current Consumption (Amps.)	11.5-14.0 @ 9 Volts
Engine Stop Solenoid Valve	
Make	Skinner Chuck Co.
Model	V5-23150
Plunger Spring	
Approx. Free Height	⅜″
Height Under Load of 4.5-5.5 oz.	$\frac{3}{16}$″

Fuel System

Fuel system units covered in this section include: fuel tank, lines, and filters; accelerator pedal and linkage; air cleaners; and system specifications. Other items, such as injectors, engine governor, fuel pump, and blower are covered in current Diesel Engine Maintenance Manual. Approved specifications for Diesel fuel oil will be furnished upon receipt of request.

FUEL TANK AND LINES

Schematic layout of fuel tank, lines and filters is shown in figure 1. Tank is installed in compartment at right side of coach and is equipped with a signaling device which emits a whistling sound as tank is filled. Two fuel lines run from tank to engine compartment at rear of coach. Pump at engine draws fuel through supply line and primary filter and discharges fuel through secondary filter and into fuel manifold passage in engine left-hand cylinder head. Crossover lines connect fuel passages in left and right cylinder heads at front of engine. Surplus fuel is returned to tank through return line. Primary filter (fig. 7) on some 6-cylinder engines is cleanable type while secondary filter (fig. 10) is renewable element type. Latest coaches are equipped with filters mounted on engine as shown in figure 8, and use renewable filters. Refer to "Fuel System Maintenance" later in this section for method of servicing. Check valve located near primary fuel filter inlet serves to keep supply line full of fuel while servicing filters, or when fuel lines are disconnected in engine compartment. The restricted fitting in return line at engine junction bracket serves to assure the fuel pressure required to feed injectors.

ACCELERATOR AND LINKAGE

Accelerator pedal and linkage at front of coach is shown in figure 2. Pedal movement is transmitted to rear of coach through flexible cable encased in metal tubing. Linkage in engine compartment is shown in figure 4.

Adjustable stop screw at floor limits accelerator pedal travel. Boots are clamped in place at control cable telescopic ends to exclude dust and moisture. Linkage at front of coach (fig. 2) is accessible from below vehicle. Operation and maintenance of accelerator interlock air cylinder (8, fig. 2) is covered in BODY (SEC. 3) of this manual.

ACCELERATOR LINKAGE REPLACEMENT AND ADJUSTMENT

Key numbers in text refer to figure 2, except as otherwise indicated.

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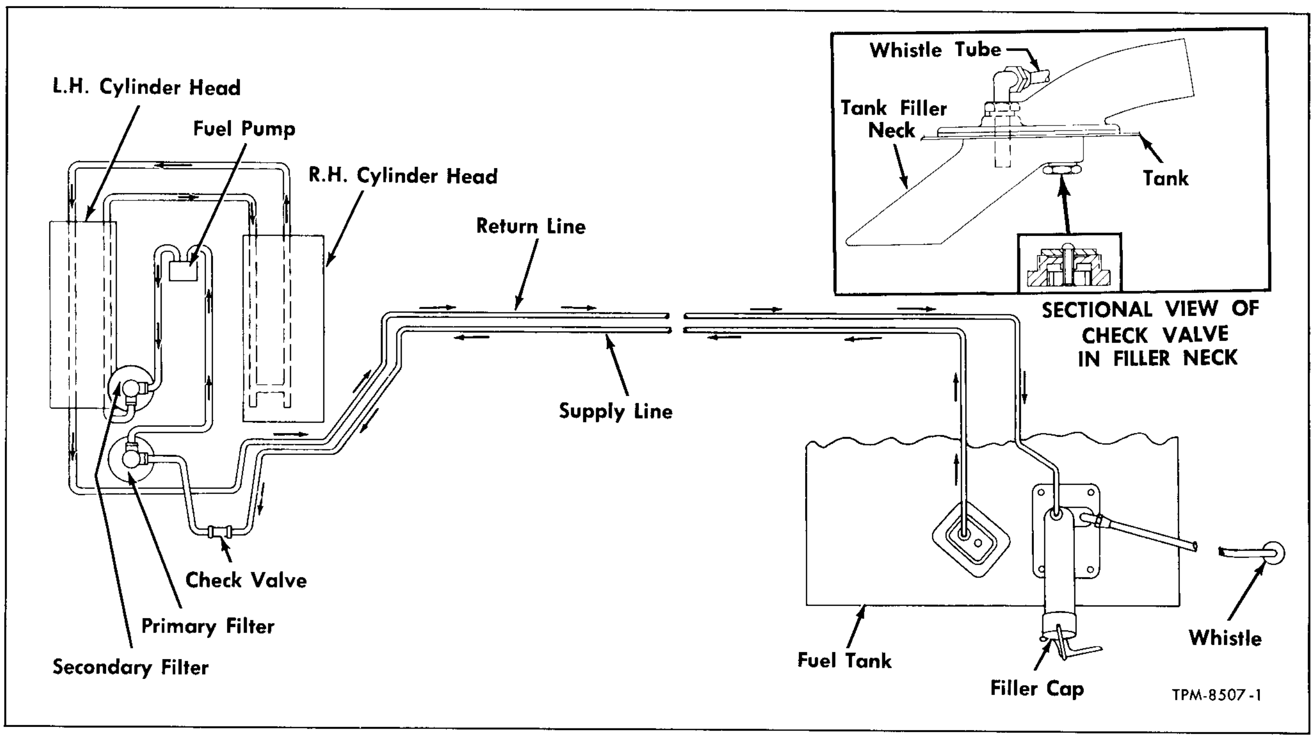


Figure 1—General Arrangement of Fuel Tank, Lines, and Associated Units

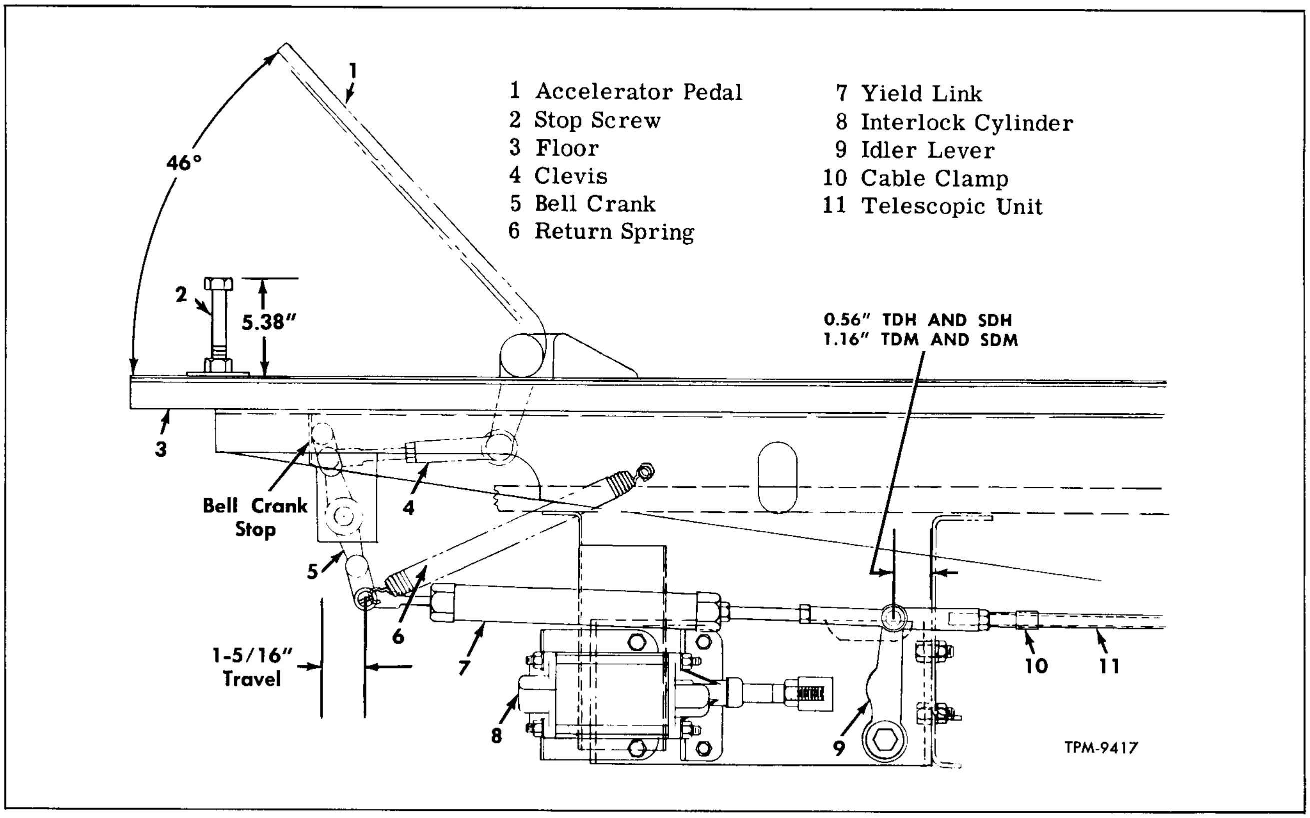


Figure 2—Accelerator Pedal and Linkage At Front of Coach

Removal

1. Unhook spring (6) at front end of coach below floor.
2. Loosen cable clamp (10) and remove lock; then if necessary to remove cable, loosen clamp 4, fig. 4) and remove lock in engine compartment then pull cable out of conduit.
3. At front end, remove clevis pins and attaching parts to remove accelerator interlock (when used) yield link (7), or cable outer slider end on coaches without interlock, bell crank (5) etc.
4. Removing clevis pin (5) and flat washers (fig. 4) at bell crank on engine permits removal of clevis and adjustable yoke (6) (fig. 4) with boot as an assembly.

Cleaning and Inspection

1. Wash cable in suitable cleaning solvent to remove old lubricant.
2. Carefully examine cable for kinks and for broken strands. If any damage is evident, new cable must be installed. Overall length of cable is 510 inches. Ends of new cable must be chamfered by grinding. To prevent frayed windings, grinding must be done only in direction of outer windings.
3. Inspect cable conduit for breaks, dents, and flat spots. Any condition which would prevent free movement of cable necessitates replacing damaged section of conduit.

CAUTION: When replacing conduit, make sure it is clean and that cable will pass through it freely. Use extreme care in installing conduit to prevent bending or flattening.

Front Linkage Installation and Adjustment

Key numbers in text refer to figure 2.

1. Assemble front linkage components as shown in figure 2. On coaches with hand throttle (fig. 3) the hand throttle lever must be assembled on bellcrank pin as shown in figure 5. With return spring (6) installed so upper end of bellcrank (5) is held against stop on bracket, adjust clevis (4) as necessary to position pedal (1) at 46-degree angle as shown.
2. Adjust stop screw (2) to 5.38" height as shown and check operation of pedal.

NOTE: If pedal position and stop screw height are correct, lower end of bellcrank (5) will travel 1-5/16 inches as pedal is depressed from released position to stop screw.

3. On coaches equipped with accelerator interlock, assemble yield link assembly (7), idler lever (9), and telescopic unit (11), with clamp (10) and boot. Adjust clevis on yield link (7) so clevis

pin will be to dimension shown in figure 2, from bulkhead.

4. On coaches not using accelerator interlock, attach telescopic unit assembly to bellcrank (5).

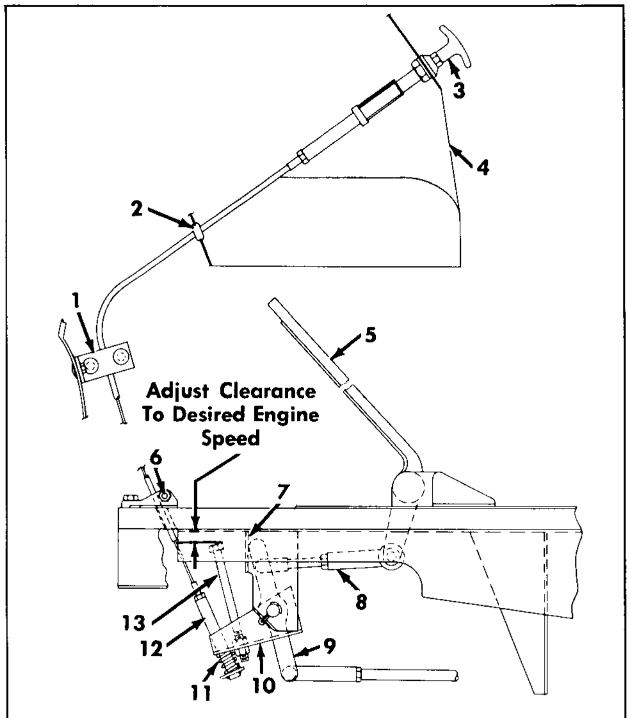
5. Before clamping boot in place, lubricate inner and outer tubes of telescopic unit with special lubricant and adjust outer tube in clevis so there is 3/8 inch from end of outer tube to swivel (fig. 4).

6. Fit boot over swivel and clamp forward end to outer tube with breather hole downward.

Installing Cable

1. Dip end of cable in special lubricant as specified in LUBRICATION (SEC. 13) of this manual, then feed cable into conduit from rear end applying lubricant to cable as cable is installed. Continue to feed cable into conduit until cable emerges at front end of front telescopic unit (11, fig. 2). Test cable for free movement.

2. Install lock to secure cable to front telescopic unit (11, fig. 2). Slide clamp (10, fig. 2) over lock and tighten clamp bolt. Install rubber seal on front end of cable and push seal against sliding end.



1 Upper Guide Bracket	8 Adjustable Yoke
2 Grommet	9 Bell Crank
3 Throttle Handle	10 Throttle Lever
4 Instrument Panel	11 Spring
5 Accelerator Pedal	12 Cable End
6 Lower Guide Bracket	13 Adjustable Stop Bolt
7 Stop Bracket	TPM-9418

Figure 3—Hand Throttle Installation (Spec. Equip.)

Installation and Adjustment of Linkage in Engine Compartment

Key numbers in text refer to figure 4.

1. If link assembly (8) is removed, adjust length so ball studs will fit into lever and bellcrank (7) and lever (10) with approximately 3-3/4 inch between hole center lines as shown.

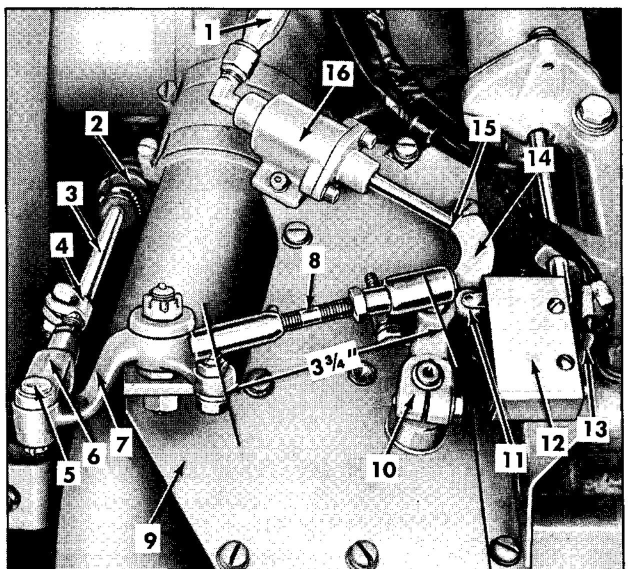
2. Lubricate inner and outer tubes of telescopic unit sliding end (3) with special lubricant, slide boot (2) on outer tube. Block accelerator pedal down against stop screw, then place outer sliding end (3) over cable and inner tube. While holding sliding end (3) 3/8 inch from swivel (fig. 5) install cable lock, slide clamp (4) over lock and tighten clamp bolt.

3. Cut off excess cable which may protrude more than 1/2 inch beyond end of threads on sliding end (3). Install rubber seal on rear end of cable and push seal tight against sliding end.

4. Release accelerator pedal. Fit boot (2) on swivel and clamp rear end to sliding end (3).

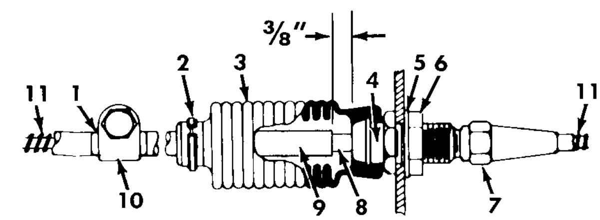
5. Install lock nut and adjustable yoke on threads at end of sliding end (4).

6. Using clevis pin and two flat washers as shown, connect sliding end yoke to bellcrank (7). Secure clevis pin with cotter pin.



1 Air Line	10 Throttle Lever
2 Sliding End Boot	11 Switch Lever Roller
3 Outer Sliding End	12 Switch Cover
4 Clamp	13 Wiring Terminals
5 Clevis Pin	14 Engine Stop Lever
6 Adjustable Yoke	15 Clearance Point
7 Bell Crank	16 Shut-off Air Cylinder
8 Link Assembly	
9 Governor Housing Cover	TPM-9337

Figure 4—Accelerator Linkage At Engine Governor



1 Cable Lock
2 Boot Clamp
3 Boot
4 Swivel Assembly
5 Lock Washer
6 Nut
7 Conduit Nut
8 Inner Sliding End
9 Outer Sliding End
10 Clamp
11 Cable

TPM-7354

Figure 5—Installation At Sliding Ends

Setting Engine Shut-off Lever Position

Key numbers in text refer to figure 4, unless otherwise indicated.

1. With air pressure at 80 pounds or more, and "MASTER" control switch in "OFF" position, try moving shut-off lever (14) away from piston rod (16). It should be possible to move lever (14) approximately 1/16 inch away from piston rod air cylinder (16) at point 15.

2. If procedure in step 1 above shows a tight condition between rod and lever or if lever can be moved more than 1/16 inch, set position of lever (14) on governor shaft as directed in following step.

3. Exhaust air from shut-off air cylinder (16). Loosen clamp bolt on lever (14) sufficiently to permit lever to be pivoted on shaft with medium to heavy friction. Push lever toward piston rod. Turn engine control switch to "OFF" position to apply air to shut-off air cylinder (16), then with air applied to cylinder carefully pull shut-off lever away from end of rod to provide 1/16 inch at point 15, as described in step 1 above. Tighten clamp bolt in lever (14) to lock lever to governor shaft.

ENGINE MODULATING RELAY OVERRULE SWITCH

Key numbers in text refer to figure 4.

Engine modulating relay overrule switch is installed at engine governor housing and mounted on bracket which has elongated holes to permit moving the switch and cover.

Switch Replacement and Adjustment

Removal

1. Remove wires from switch terminals (13).

2. Remove two bolts which mount switch and cover on bracket. Separate switch and cover.

Installation and Adjustment

1. Be sure governor housing cover screws which attach switch bracket are tight. Place cover over switch and insert two switch mounting bolts through holes in cover and switch.

2. Position switch assembly on bracket and loosely install nuts and lock washers on mounting bolts.

3. With air exhausted from shut-off air cylinder (16) and accelerator released (governor linkage in idle position), move switch assembly so roller (11) contacts lever (10). Carefully move switch toward lever until faint click is heard which indicates that roller lever has actuated the switch, then tighten switch mounting bolts.

4. Attach wires to two end terminals (13), as shown. Center terminal on switch is not used.

5. Operate linkage to determine if lever (10) contacts roller (11) and breaks circuit when linkage returns to idle position.

FUEL SYSTEM MAINTENANCE

AIR INTAKE

ENGINE AIR INTAKE (Fig. 6)

Air for engine is taken in through two screened openings - one above each rear side window. Air passes through ducts which lead to air cleaners mounted to duct above engine compartment. After passing through air cleaners the air enters air cleaner manifold to which is connected the blower air intake. Arrows on figure 6 indicate direction of air flow.

Air supply for air compressor is drawn through hose installed between compressor inlet fitting and an elbow on pipe below air cleaner manifold.

A removable cover is provided at location shown in figure 6 for cleaning intake air ducts.

AIR CLEANERS

Air cleaners are used to remove dust and dirt before it reaches Diesel engine blower. Air cleaners are accessible from engine compartment. Refer to cross section view of air cleaner in figure 6 for construction. Intervals for servicing air cleaners and method of cleaning is contained in LUBRICATION (SEC. 13) of this manual.

SERVICING AIR CLEANERS AND AIR INTAKE SCREENS (Fig. 6)

Importance of keeping air cleaners in proper condition should be impressed on those responsible for mechanical upkeep of engine.

Unless air cleaners are cleaned periodically as service conditions require, they will not function

properly, and in some instances, actually aggravate the condition which they are designed to prevent.

When air cleaner is loaded and dirty, and is used past its saturation point, some of this fine abrasive will get past cleaner and cause considerable damage to pistons, cylinder walls, and bearings.

For those reasons, air cleaners must be cleaned at regular intervals as specified in LUBRICATION (SEC. 13) of this manual.

Periodic inspection should be made at air intake openings to determine if screens have become clogged. Screens are held in place by screws and screens can be removed for cleaning. An access plate shown in figure 6 can be removed to permit cleaning of intake air duct when necessary.

PRIMARY FILTER (CLEANABLE ELEMENT TYPE)

Fuel oil filters are shown in figures 7 and 8. In order for filters to function properly, they must be given proper care. Service in following manner:

Primary filter (fig. 7) must be drained frequently, because if water is present in the fuel it is most likely to accumulate in this filter. No definite draining periods can be given here, inasmuch as the necessity for draining depends upon the cleanliness of the fuel put into the fuel tank. It is recommended, that a small amount of fuel oil be drained from this filter daily, noting the water content (if any), then from this experience definite draining periods may be established. Drain filter by opening drain cock at bottom of filter. If water in any amount is regularly found in this filter, it is an indication that something is wrong in the

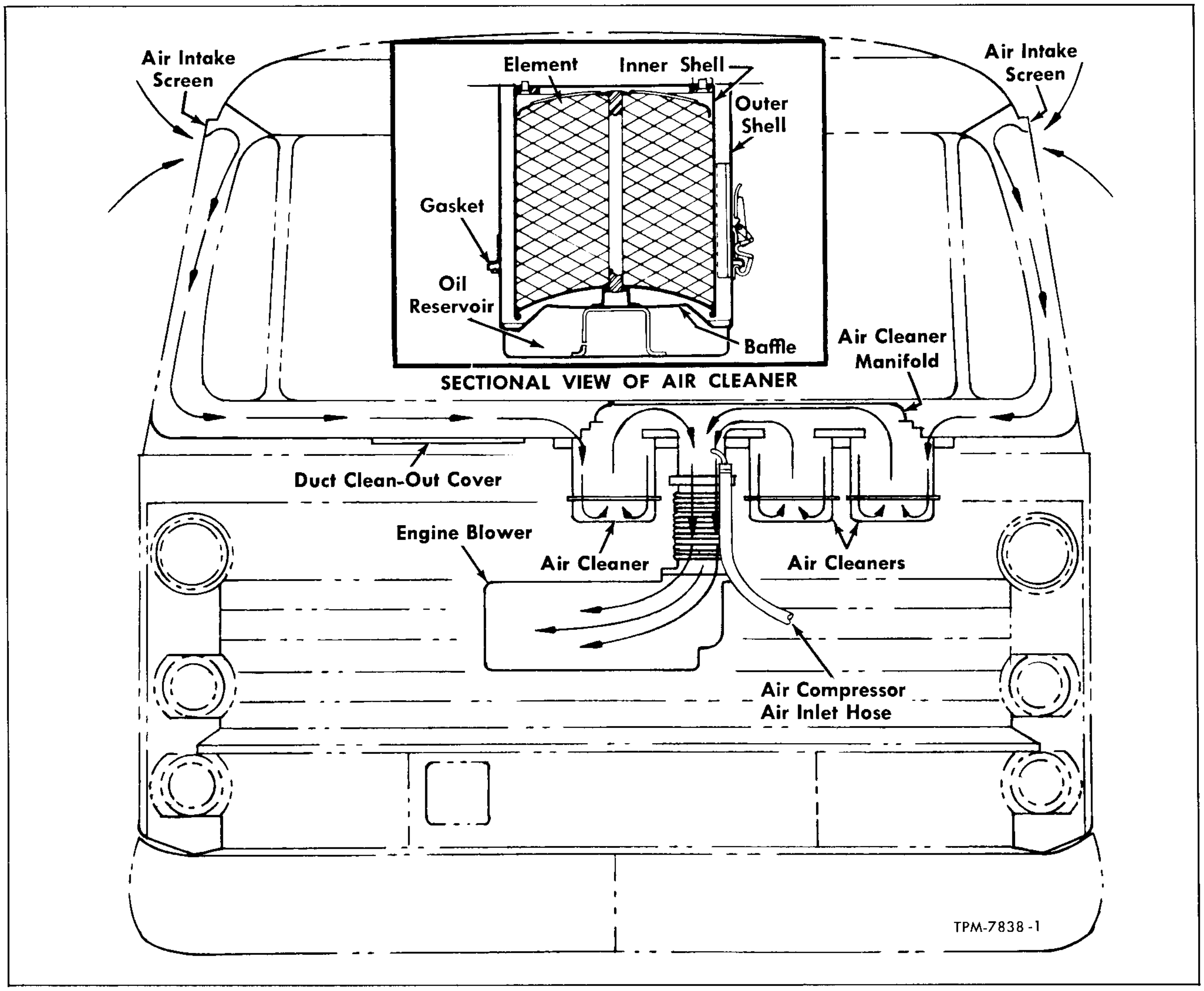
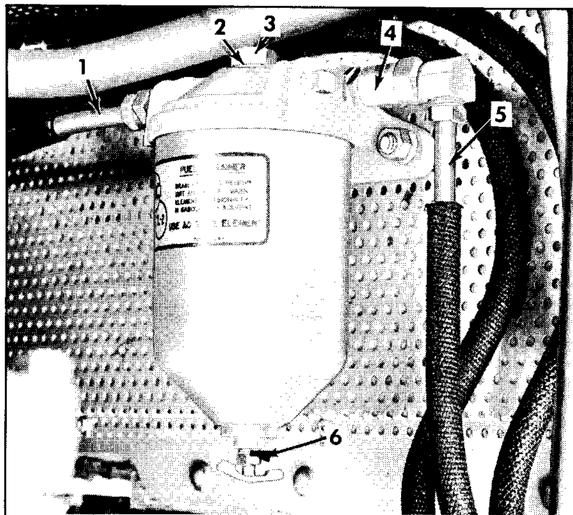


Figure 6—Air Intake System—6 Cylinder Shown



1 Line to Engine
2 Gasket
3 Bolt
4 Check Valve
5 Line from Tank
6 Drain Cock TPM-6994

Figure 7—Primary Fuel Filter Installed—Early Models

method of handling and storing of the fuel oil and a thorough investigation must be made to eliminate the trouble; then the fuel tank lines and both filters should be drained and cleaned. The only water that will normally accumulate in the fuel system is from condensation in the fuel tank.

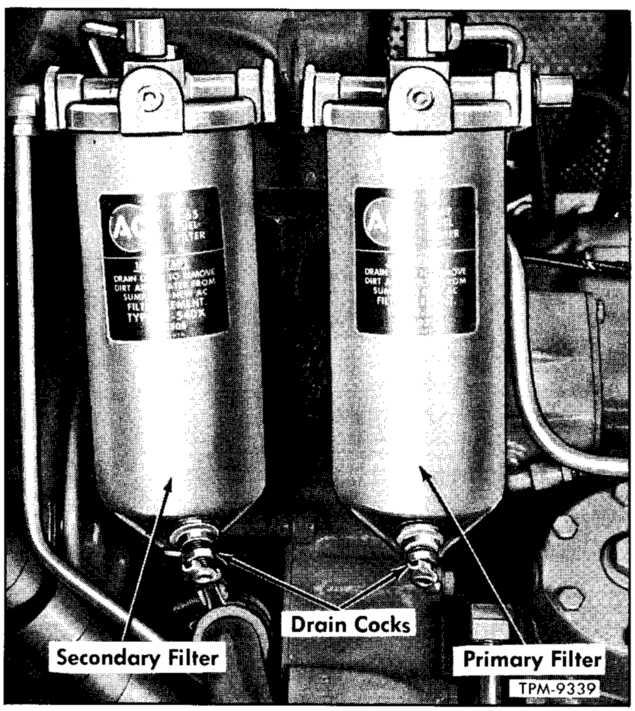


Figure 8—Primary and Secondary Fuel Filters Installed—Late Models

Cleaning Primary Filter

Key numbers in text refer to figure 7.

In addition to periodic draining as described in preceding paragraph, filter should be thoroughly cleaned every 5,000 miles as follows:

1. Open drain cock (6) at bottom of filter and allow filter to drain.
2. Remove bolt (3) at top of filter and withdraw housing and edge-type filter element. Lift filter element out of housing.
3. Wash all filter parts, including element, in a suitable cleaning solvent. Be sure all particles are removed from between disks of element. Use air if necessary.
4. Inspect filter housing gasket, element gasket, and bolt gasket; replace if not in good condition.
5. Reassemble filter and inspect carefully for leaks. Be sure drain cock is closed tightly.

NOTE: In the event check valve (4, fig. 7) is removed from primary filter, always reinstall with word "TOP" facing upward.

PRIMARY AND SECONDARY FILTERS

Two fuel oil filters, mounted on engine as shown in figure 8, and sectionally illustrated in figures 9 and 10 are used on all 8V and latest 6V engines.

Primary filter assembly uses a "sock" type element, while secondary filter element is a paper type. Elements are not cleanable and must be replaced whenever their efficiency is impaired due to accumulation of foreign matter. In order for these filters to function properly, they must be given proper care. Service in following manner:

PRIMARY FILTER

Primary filter (fig. 9) must be drained frequently because if water is present in the fuel it is most likely to accumulate in this filter. No definite draining periods can be given here, inasmuch as the necessity for draining depends upon the cleanliness of the fuel put into the fuel tank. It is recommended, that a small amount of fuel oil be drained from this filter daily, noting the water content (if any), then from this experience definite draining periods may be established. Drain filter by opening drain cock at bottom of filter. If water in any amount is regularly found in this filter, it is an indication that something is wrong in the method of handling and storing of the fuel oil and a thorough investigation must be made to eliminate the trouble; then the fuel tank lines and both filters should be drained and cleaned. The only water that will normally accumulate in the fuel system is from condensation in the fuel tank.

Replacing Primary Filter

In addition to periodic draining as described in preceding paragraph, element should be replaced and filter should be thoroughly cleaned every 5,000 miles as follows:

1. Open drain cock at bottom of filter and allow filter to drain.
2. Remove bolt at top of filter and withdraw shell and filter element assembly. Lift filter element out of shell and discard element.
3. Wash all filter parts, in a suitable cleaning solvent.
4. Inspect filter housing gasket, element gasket, and bolt gasket, replace if not in good condition.
5. Install new element in filter shell, then install shell to cover. Tighten retaining bolt.
6. When engine has been started check carefully for oil leaks.

SECONDARY FILTER

It is recommended that secondary filter (fig. 10) be drained at same intervals as primary filter. Refer to "Primary Filter" in previous paragraph for intervals.

In addition to draining, the following check should be made at intervals of approximately 5,000 miles to determine the condition of the element, This check may be made by disconnecting outlet fuel line at filter and installing a pressure gauge connected to a "tee." Start engine and note presure on gauge. If the pressure reading is less than 15 lbs. at 2,000 rpm, the element must be removed and replaced. Do not open the filter except at time of element replacement. Replacement usually will be required every 10,000 miles or 500 hours. DO NOT ATTEMPT TO CLEAN AND REINSTALL FILTER ELEMENT.

Replacing Secondary Filter Element

If periodic check, as described in previous paragraph, indicates filter element should be changed, proceed in same manner as described in paragraph under heading "Replacing Primary Filter."

ACCELERATOR CONTROLS

Lubrication and Inspection

Clevis pins and pivot points at accelerator control linkage must be lubricated periodically as instructed in LUBRICATION (SEC. 13). Cable and sliding ends are lubricated at time cable is installed and periodic lubrication is not required; however, the boots (3, fig. 5) should be inspected at regular inspection intervals. If boots or cable require replacement, lubricant as specified in LU-

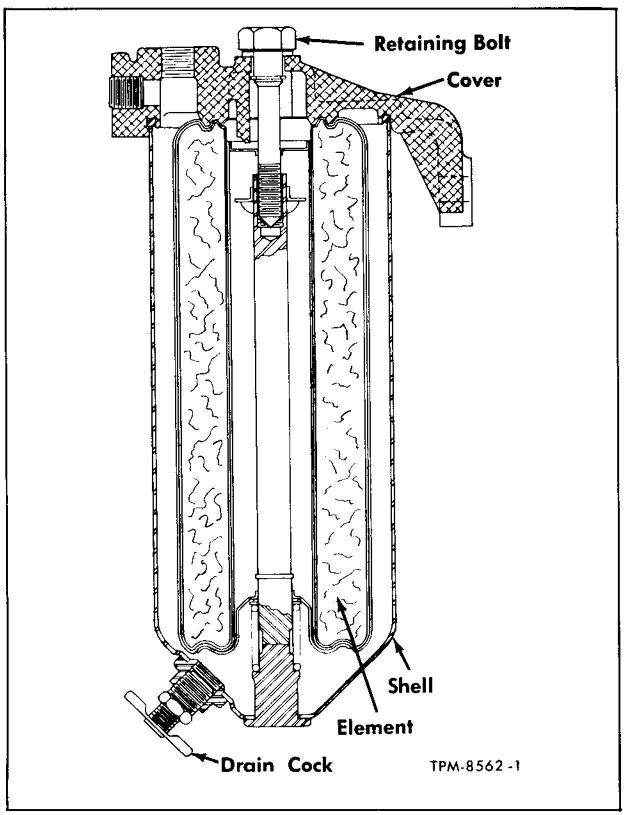


Figure 9—Sectional View of Primary Fuel Filter

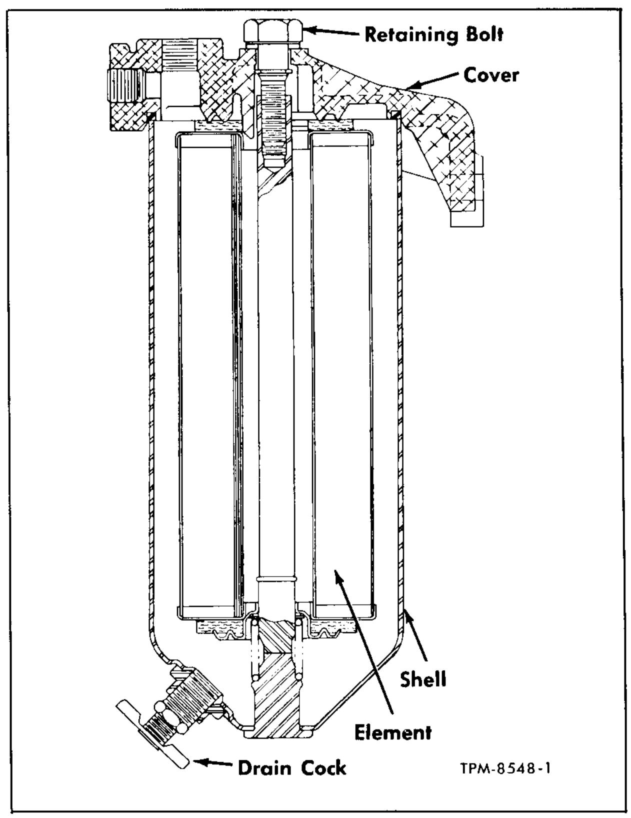


Figure 10—Sectional View of Secondary Fuel Filter

BRICATION (SEC. 13) of this manual, must be applied. Since correct adjustment of accelerator controls is necessary to prevent excessive strain on linkage, a periodic check should be made to assure proper adjustment as previously described under "Accelerator Linkage Replacement and Adjustment," in this section.

EMERGENCY STOP MECHANISM

Inspection

Make periodic inspection of emergency stop solenoid to assure its being operative. Mounting bolts must be tight and wire connection clean and tight. Refer to ENGINE (SEC. 8) for other maintenance procedures and for solenoid specifications.

SPECIFICATIONS

FUEL FILTER	
Primary (On Engine Bulkhead)	
Make	AC
Type	Cleanable Strainer
Strainer Model	TL-12
Primary (On Engine)	
Make	AC
Type	Disposable
Element Type No.	T-552
Secondary	
Make	AC
Type	Disposable
Element Model	TP-540X
AIR CLEANERS	
Number Used	(3-6V or 4-8V)
Make	AC
Type	Oil Bath
Capacity	2 Qts. Ea.
FUEL TANK	
Capacity	95 gal.

Lubrication

USE OF CHART

The separate lubrication chart at back of this manual indicates location of points requiring periodic lubrication. This chart will serve the purpose of approximately locating various fittings and points of lubrication. When necessary, more detailed information on accessibility of lubrication points is described in following paragraphs.

INTERVALS

Intervals indicated on the chart are recommended for normal service. More frequent intervals may be used, if necessary, under severe operating conditions.

LUBRICANTS

Types of recommended lubricants are indicated on the chart by symbols. Descriptions of these lubricants are given in following paragraphs covering each type of lubricant. In the selection of the proper type of lubricants, the reputation of the oil supplier must be considered, as he must be responsible for the quality of his product. The descriptions of the lubricants given will assist the coach operator to demand the correct quality and type.

MEANING OF LUBRICANT SYMBOLS

Symbol	Type of Lubricant
E	Engine Oil
SG	Steering Gear Lubricant
MP	Multi-Purpose Gear Lubricant
C	Chassis Lubricant
S2	High Temperature Grease
S3	Petroleum Jelly (Petrolatum)
S7	Refrigeration Machine Oil
S19	Type A Fluid
S20	Special Lubricant
S25	Air Conditioning Compressor Oil
S26	Special Multi-Purpose Grease

METHODS OF LUBRICATION

Various methods of applying lubricant are described in following paragraphs.

Whenever cleaning, removal, or disassembly procedures are necessary to lubricate various units, such procedures are listed in applicable sections in the manual.

LUBRICATION AT ASSEMBLY

In addition to items shown on chart, some items require lubrication only at assembly. Refer to applicable section in manual for lubrication procedures on such items.

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ENGINE OIL
(SYMBOL "E" ON CHART)

TYPES OF OIL

Crankcase oils in service, unless protected by suitable addition agents, oxidize, form sludge and varnish, and under some driving conditions corrosive acids may accumulate in the crankcase. Heavy Duty engine oils minimize the formation of these harmful decomposition products and generally aid in obtaining extended trouble-free service.

The oil industry markets various types of engine oil under certain service designations, such as "ML," "MM," "MS," "DG," "DM," and "DS." Best quality heavy duty engine oils are designated as for service "DG," "DM," or "DS."

RECOMMENDATIONS

The responsibility for engine oil quality and performance - the application of the engine oil to the particular engine operating conditions - must remain with the engine oil supplier.

The selection of a reliable supplier, therefore with close attention to his oil and filter element change recommendations can provide satisfactory lubrication and longer life for your engine.

Supplement 1 (S-1) heavy duty engine oils designed for service "DM" and which meet or exceed the requirements of MIL-L-2104A are recommended for use in Diesel engines.

Series 3 type engine oils (for service "DS") should be used only to overcome sludging conditions encountered with light load operation at temperature of 0^{o}F. or below.

In some types of operation, multiviscosity engine oil may prove to be satisfactory. Application of this type of oil should be worked out with the supplier on his assurance of quality and satisfactory performance of his product in your engines.

LUBRICATION

Regardless of oil type used, suppliers should assure the following in furnishing oil for GM Diesel engines:

1. Good resistance to "scuffing" or excessive wear.
2. Good resistance to formation of high or low temperature deposits.
3. Good protection against rust and corrosion.
4. Good resistance to oxidation, thinning out in service, and excessive consumption.

"The use of proprietary blends of supplementary additives or concentrates such as engine oil supplements, break-in oils, tune-up compounds, friction reducing compounds, etc., is not recommended in lubricating oils of the Diesel engines in GMC Truck & Coach vehicles. A lubricating oil additive is available from GMC Dealers specifically for gasoline engines."

CHANGING OIL

The engine is initially filled with lubricating oil of high quality. This oil should not be drained until the regular change period that has been established for your operation.

The intervals at which crankcase oil should be changed depend entirely upon the type and quality of oil used, the severity of vehicle operation, and the mechanical condition of the engine. Oil changing is closely related to filter element and air cleaner element changing. THE OIL MUST BE CHANGED OFTEN ENOUGH TO KEEP IT NON-ABRASIVE, NONCORROSIVE AND REASONABLY CLEAN. It is imperative that regular intervals be established and crankcase oil and oil filter element be changed regularly.

Crankcase should be drained only after running when oil is hot.

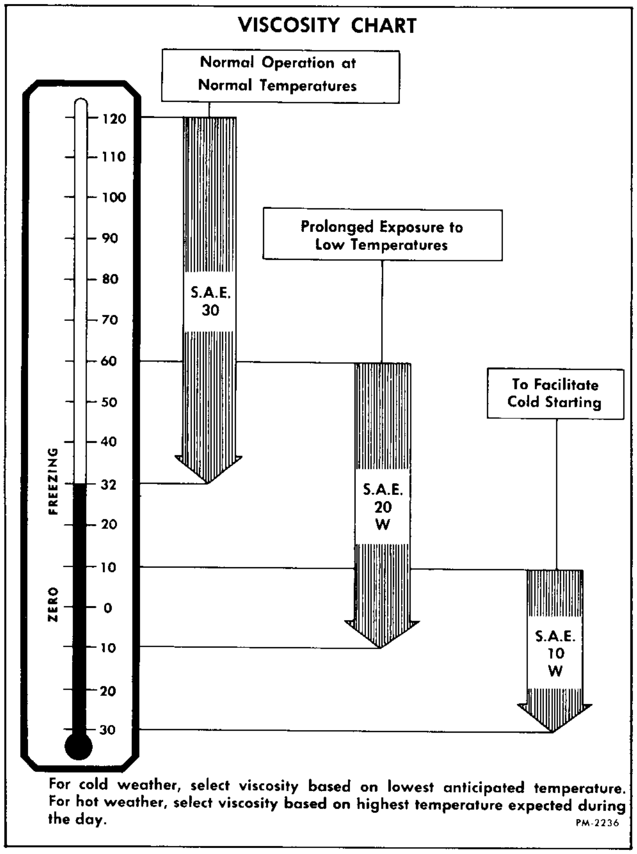


Figure 1—Engine Oil Viscosity Chart

OIL CHANGE PERIODS

In general service, using fuels conforming to GMC fuel recommendations, and using oil of MIL-L-2104A Supplement 1 or A.P.I. Service Classification "DM," drain crankcase every 4,000 miles or 30 days, whichever occurs first (see Note 1).

If Series 3 oil is used, oil change period should be on oil suppliers recommendation (see Note 1).

Note 1

Use of independent laboratory oil analysis reports or oil supplier recommendation should be made to determine if more or less frequent oil and filter change periods are required, or possible.

VISCOSITIES

Atmospheric temperatures and severity of service determine the viscosity grade of engine oil to use. Viscosity numbers constitute a classification of lubricants in terms of viscosity or fluidity, but with no reference to any other characteristics or properties.

As a guide to the selection of the proper grade or viscosity of oil to be used at various atmospheric temperatures, refer to "Viscosity Chart" shown in figure 1. If cold starting is a problem, use of lighter oil will lessen starting difficulties.

CHECKING OIL LEVEL

Daily, or oftener if necessary, check oil level. Make the check preferably after a day's run and after engine has been stopped for a few minutes. Remove dipstick, wipe clean with cloth, reinsert and remove again. The upper mark on engine oil dipstick is "FULL," the lower "ADD." Keep level as close as possible to "FULL" mark without overfilling. Do not operate with level below "ADD" mark.

TRANSMISSION (MECHANICAL)

Transmission lubricant should be Heavy Duty engine oil of the same type as used in engine.

VISCOSITY

During summer (Above 32°F.) use S.A.E. 30 or S.A.E. 20 during winter (Below 32°F.).

CHECKING LEVEL

Transmission oil level dipstick is marked "OIL LEVEL." The dipstick is located in a tube at side of transmission and is accessible after transmission compartment door is opened.

Oil level should be checked immediately after a run when the oil in transmission is hot. The oil level should then be at "OIL LEVEL" mark on dipstick.

DRAINING

Drain after first 3,000 miles of operation and thereafter at recommended intervals.

Transmission should be drained while unit is warm, preferably immediately after a run. Drain plug is located in the transmission case sump at bottom of flywheel housing and is accessible under the engine compartment after compartment bottom pan is dropped. On wet clutch, also remove plug at bottom of flywheel housing to completely drain the transmission and clutch. Magnetic type plugs should be thoroughly cleaned before reinstalling

FILLING

After thoroughly draining, fill through filler plug hole at top of transmission. Run engine several minutes, then recheck oil level at dipstick immediately after stopping engine. Level should be brought to "OIL LEVEL" mark on dipstick.

OTHER ENGINE OIL USES

BLOWER AIR CLEANERS

Blower air cleaners, accessible after engine compartment door is raised, should be serviced at intervals recommended on chart. If service conditions warrant, cleaning and servicing intervals should be more frequent.

1. Release two latches near bottom, then pull reservoir downward.
2. Lift oil baffle from reservoir, then pour oil from reservoir. Clean reservoir and baffle in cleaning fluid to remove all accumulated deposits.
3. Pull element downward and out of cleaner body. Slush element up and down in bath of cleaning fluid, until all oil and dirt deposits are removed. Permit element to dry thoroughly, but do not use compressed air.
4. Whenever inspection indicates that space between body and liner is restricted, liner should be removed and cleaned.
5. Reinstall element in body liner, being sure that element is pushed up as far as possible.

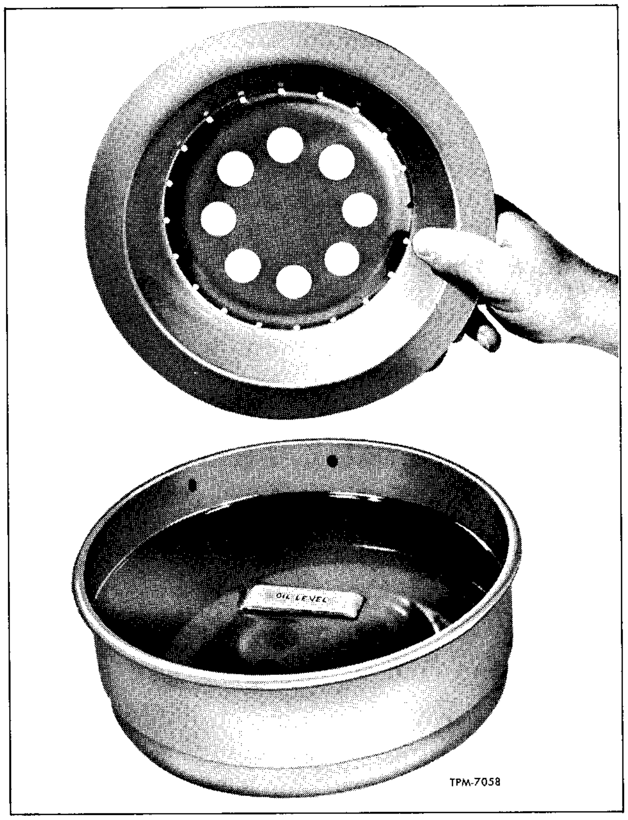


Figure 2—Oil Level In Air Cleaner Reservoir

6. Fill reservoir up to "OIL LEVEL" mark on bracket at center of reservoir (fig. 2) using same grade of oil as used in engine. Install oil baffle at center of reservoir.
7. Install reservoir to cleaner body, then secure with two latches.

OIL FILTERS

Two engine oil filters are used on these vehicles. One filter is mounted near front of engine and is a "full-flow" type, also another filter is mounted at right engine cradle support and is a "by-pass" type.

Element changing periods are closly related to crankcase oil changing periods, the quality of oil used, and the type of operation.

"Full-Flow" Element Replacement

1. Remove drain plug from filter housing and drain oil from filter.
2. Loosen filter housing bolt, then remove bolt from housing. Remove element from housing.
3. Wipe out housing thoroughly. Check gasket surface at top of housing for dirt and burrs which might cause air leaks.
4. Install new element in housing. Install housing on filter base with filter drain plug away from engine.

5. Run engine for a few minutes. Check filter for leaks; then check dipstick level. Add oil to bring up to (not above) "FULL" mark on dipstick.

"By-Pass" Element Replacement

1. At engine cradle support, remove two bolts attaching filter mounting bracket to support.
2. At bottom of shell, loosen through bolt until shell and element assembly can be removed from base.
3. Remove element from shell and discard.
4. Clean shell thoroughly to remove all deposits of oil, dirt and so forth.
5. Install new element in shell. Position shell and element to base and tighten through bolt. Secure mounting bracket to engine cradle support.
6. Run engine for a few minutes. Check filter for leaks, then check dipstick for oil level. Add oil to bring up to (not above) "FULL" mark on dipstick.

CLUTCH AND AIR CONDITIONING AIR CYLINDER

Air cylinder is equipped with a square head pipe plug at end. At recommended intervals, remove plug and apply one ounce of S.A.E. 10 engine oil.

CLUTCH CONTROL VALVE (MECHANICAL)

Clutch control valve is equipped with a ball oiler and air filter. At recommended intervals apply oil through oiler, also remove, clean, and reinstall filter.

STARTER

Starter is equipped with plugs at commutator, center bearing, and drive ends. At specified intervals, remove plugs and apply lubricant.

CONTROL ROD LINKAGE

All control rod linkage pins and joints should be oiled regularly with light engine oil. Use can or spray.

MULTI-PURPOSE LUBRICANT (SYMBOL "MP" ON CHARTS)

Multi-purpose gear lubricant must satisfactorily lubricate heavy duty coach axles under maximum torque and speed conditions. It must provide necessary and suitable load-carrying characteristics to prevent scoring and wear, good stability in storage and service, and give good resistance to corrosion. Suppliers should assure these characteristics and be responsible for the quality and satisfactory performance of their product. Many oil companies can supply lubricant, conforming with above description, under the requirements of Military Specification MIL-L-2105B or Timken Specification 0-65 (0-64 for cold weather).

REAR AXLE

Checking Level

At intervals indicated on chart, remove filler plug in differential cover. Add sufficient lubricant to bring level up to filler plug opening. Install and tighten plug. Check level after a run or while differential is warm.

Viscosity

S.A.E. 140 should be used the year around, except in cases of extremely low temperatures. If vehicle is parked in temperatures below +20°F., or operated in temperatures consistently below 0°F., it is advisable to use S.A.E. 90.

Draining and Filling

When axle is new, or after overhaul, it is recommended that lubricant be drained after first 3,000 miles of operation, and thereafter at recommended intervals. Draining at an early mileage removes fine particles of metal or other foreign material.

At recommended intervals, remove plug at bottom of housing to drain lubricant. Drain when unit is hot, preferably immediately after operation. Reinstall and tighten drain plug.

Fill axle to level of filler plug in housing cover. Install and tighten level plug. Capacity of rear axle is indicated on chart.

STRAIGHT GEAR OIL (SYMBOL "G" ON CHART)

Type of lubricant indicated by the symbol "G" on chart must be a straight mineral gear oil of the best quality.

UNIVERSAL JOINTS

At recommended intervals, use pressure gun to apply lubricant through fitting in universal joint trunnion. Apply until lubricant is forced out around trunnion seats. Use S.A.E. 140 the year around.

STEERING GEAR LUBRICANT (SYMBOL "SG" ON CHARTS)

The lubricant indicated by the symbol "SG" is a special steering gear lubricant, No. 0 grade with low cold test characteristics and extreme pressure properties. This type of lubricant is marketed by many oil companies. In the event that low cold test extreme pressure lubricant meeting the above specifications cannot be obtained, use #1 Multi-Purpose (lithium base) grease. Multi-Purpose "MP" lubricant may be used for make-up only.

STEERING COLUMN BEVEL GEAR HOUSING

Steering column gear housing is accessible from underneath at left front corner of coach. Clean breather at top of housing. Fill housing through fitting at bottom of housing, until lubricant is level with breather.

STEERING GEAR HOUSING

Steering gear housing is located on top of front axle. Clean breather in housing. Fill housing through fitting at bottom of housing, until lubricant is level with breather.

SPEEDOMETER AND TACHOMETER CABLES

Remove inside cable from cable housing. Coat lightly with lubricant and avoid excessive amount.

CHASSIS LUBRICANT (SYMBOL "C" ON CHART)

Chassis lubricant should be a high grade calcium, lithium, or aluminum soap pressure gun lubricant. Sodium soap grease may be used as chassis lubricant, but more frequent application may be required during wet weather. This lubricant should be used at all points indicated by the symbol "C" on chart.

Good quality multi-purpose lithium soap grease is recommended, especially for extreme operating conditions - water, heat, etc.

All pressure gun lubrication fittings must be clean before applying gun. Apply sufficient lubricant to thoroughly lubricate entire bearing or bushing.

LOCATION OF POINTS

The chart at back of book shows relative location of chassis lubrication points. Location described in following paragraphs, however, will assist in readily locating these points.

ENGINE COMPARTMENT

Speedometer Adapter (When Used)

FRONT DOOR HINGES

Lower hinge fitting is accessible at underside of coach. Upper hinge is accessible inside coach.

REAR DOOR HINGES

Rear door hinge lubrication fittings are accessible at underside of coach.

INSIDE COACH

Accelerator Pedal
Destination Sign Gears

UNDER VEHICLE (FRONT)

Steering Knuckles
Steering Tie Rod Ends
Steering Drag Link Ends
Steering Prop. Shaft U-Joints
Steering Prop. Shaft Slip Joint
Front Slack Adjusters
Front Brake Camshafts
Accelerator Interlock Lever

UNDER VEHICLE (REAR)

Rear Slack Adjusters
Rear Brake Camshafts
Prop. Shaft U-Joints
Prop. Shaft Slip Joint
Hand Brake Camshaft
Hand Brake Relay Levers
Hand Brake Bell Crank

HIGH TEMPERATURE GREASE (SYMBOL "S2" ON CHARTS)

The type of lubricant indicated by symbol "S2" on chart, should be a short fiber, non-fluid #2 sodium soap grease having a high melting point (300°F., min. melting point). No. 2 lithium soap base certified as approved by bearing manufacturer may also be used. DO NOT MIX GREASES.

WHEEL BEARINGS

Instructions for the removal, installation, and adjustment of wheel bearings will be found in "HUBS AND BEARINGS" (SEC. 19).

Cleaning

With a stiff bristle brush and cleaning solvent, thoroughly clean bearings and hubs, making sure that all old lubricant and dirt is removed. Check bearings and cups and replace damaged parts.

Packing

When packing by hand, be sure that lubricant is kneaded between rollers and races. A mechanical lubricator can be used; however, bearings must be thoroughly lubricated.

DO NOT FILL HUB. Coat inside of hub and axle spindle with thin coat (1/8" thick) of grease to retard rusting. Allow some excess grease at open end of bearings and around adjusting nut. DO NOT PACK HUB WITH GREASE. The lubricant in bearings is sufficient to provide adequate lubrication until next service period. Readjust bearings as described in "HUBS AND BEARINGS" (SEC. 19).

CAUTION: Do not use lubrication fittings on hubs. Lubricant must not be forced into hubs.

CLUTCH RELEASE BEARING (MECHANICAL)

Clutch release bearing is lubricated from a grease cup. At recommended intervals, turn cup down one full turn. Refill cup when empty.

AIR CONDITIONING COMPRESSOR CLUTCH SHAFT

Compressor clutch shaft bearing is lubricated through a grease fitting. At recommended intervals, apply lubricant sparingly from a hand gun. Excessive lubricant may reach clutch facings.

PETROLEUM JELLY (SYMBOL "S3" ON CHART)

The type of lubricant, indicated by symbol "S3" is petroleum jelly or petrolatum.

BATTERY TERMINALS

Keep battery terminals clean. At regular intervals, remove cables; then clean terminals on cables and batteries. Apply petroleum jelly after tightening terminals to prevent corrosion.

REFRIGERATION MACHINE OIL (SYMBOL "S7" ON CHART)

Refrigeration machine oil is a highly refined straight mineral petroleum oil.

Windshield Wiper Oiler. Remove pipe plug in cover, then fill with lubricant. Replace plug.

TYPE A FLUID (SYMBOL "S19" ON CHARTS)

Fluid indicated by symbol "S19" on chart, must be an "Automatic Transmission Fluid - Type A" supplied in containers bearing mark "AQ-ATF," followed by an identification number and letter "A." DO NOT USE ANY OTHER FLUID.

POWER STEERING SYSTEM

The supply tank for power steering system is mounted with the system pump on engine timing gear housing. The level of fluid in the tank should be checked at intervals indicated on chart.

To replenish tank to "FULL" mark on dipstick remove wing nut in cover. After thoroughly cleaning around cover, remove cover. The fluid should be poured through a 200-mesh screen which may be placed or soldered in the large end of a funnel. Before using funnel, make certain that it is clean. Do not use a cloth strainer when filling or adding fluid to system. Cloth strainers contain lint which is harmful to the system. Install cover securely.

BLEEDING POWER STEERING SYSTEM

Whenever a line is disconnected or a pump is replaced, the air that has entered the hydraulic system must be bled out, otherwise noisy and unsatisfactory operation will result.

1. Fill oil reservoir and let oil remain undisturbed for about two minutes.

2. Raise front end of vehicle so that wheels are off the ground.

3. Turn the wheels to right and left to the wheel stops to eliminate air pockets in power cylinder. Continue this operation until fluid in reservoir stops bubbling. Replenish fluid in reservoir during this operation.

4. Start the engine and run at idle for two minutes. Turn wheels right and left as before. DO NOT HIT WHEEL STOPS. Recheck fluid level, and hoses and connections for leaks. Continue this operation until oil is clear of bubbles.

5. Increase engine speed to approximately two-thirds of full throttle and continue to run at this speed until all signs of bubbles disappear from oil in reservoir as wheels are turned from right to left. DO NOT HIT STOPS.

6. Lower the vehicle and turn the wheels on the ground. Recheck system for leaks. Check fluid in reservoir and refill to "FULL" mark on dipstick as previously directed.

DO NOT USE HYDRAULIC BRAKE FLUID OR SHOCK ABSORBER FLUID. CARE SHOULD BE TAKEN TO KEEP THE FLUID CLEAN AND FREE OF WATER.

AIR CONDITIONING CONDENSER FAN DRIVE

Refer to "AIR CONDITIONING" (SEC. 26) for method of draining, filling, and replenishing fluid in system.

SPECIAL LUBRICANT (SYMBOL "S20" ON CHART)

Lubricant to be used on accelerator control cables is available through AC Spark Plug Distributors as "Type ST-640." Use this lubricant or equivalent. Refer to FUEL SYSTEM (SEC. 12) for control cable lubricating procedures.

AIR CONDITIONING COMPRESSOR OIL (SYMBOL "S25" ON CHART)

This fluid is a special wax-free, non-foaming, dehydrated type of oil, having a viscosity of about S.A.E. 10. This oil is available from many major oil companies under various trade names.

Refer to "AIR CONDITIONING" (SEC. 26) for method of checking, adding, and recharging an empty system.

SPECIAL MULTI-PURPOSE GREASE (SYMBOL "S26" ON CHART)

Lubricant indicated by symbol "S26" should be a Lithium Base #2 Grease with 3% Molybdenum Disulfide, commonly called "Multi-Purpose Grease No. 2 With 3% Moly."

Whenever accessible air conditioning compressor main bearing carrier should be hand packed as described in AIR CONDITIONING (SEC. 26) of this manual.

Lubricants Must Be Stored and Dispensed in Such a Manner That They Will Be Clean and Free of Contamination Due to Dirt or Other Foreign Matter.

Air Suspension

Information in this section covers complete description, operation, and maintenance of the air suspension system. Replacement of the various air suspension components is also covered. Since replacement of the front and the rear axle consists primarily of disconnecting and connecting the air suspension components, these procedures are also included in this section.

SYSTEM DESCRIPTION

The air suspension system for the most part, is made up of suspension supports, air bellows, height control valves, radius rods, and shock absorbers. The supports provide the means by which the suspension system is connected to the axles. The system operates automatically and maintains a constant ride height regardless of load or of load distribution.

Vertical loads are supported by eight rubberized nylon fabric air bellows assemblies (fig. 2). Four 8" bellows are used at front axle and four 10" bellows are used at rear axle. Bellows are installed between beams in coach body structure and suspension supports attached to axles as shown in figure 1. Upper bead of bellows is clamped between upper retainer and mounting surface. Lower bead is clamped between lower retainer and piston. When bellows assembly is installed, beads form air-tight seals.

The pressure in air bellows is varied automatically in proportion to vehicle load by height control valves. Three height control valves, one at front axle and two at rear axle, maintain constant vehicle height for all load conditions. Height control valve levers are connected to axles by links.

Radius rods, four at each axle, transmit driving and braking forces from axles to the coach body. These rods also control the lateral and longitudinal position of each axle under the vehicle. Each end of radius rods contains a rubber bushing that requires no lubrication. Telescoping type double-acting shock absorbers are mounted at ends of each axle. Stabilizer bar, attached in rubber mountings to body, is linked at both ends to rear suspension supports. Certain model coaches also have a front stabilizer bar.

Suspension supports at front axle and at rear axle are welded steel assemblies. Front suspension support includes bellows lower mountings. Four mounting studs are welded in place and attach to radius rod bracket. Rear suspension support includes mounting brackets for radius rod and shock absorber, bellows, stabilizer bar link, and brake chamber. Suspension support is bolted to axle bracket. Bracket is welded to axle.

SYSTEM OPERATION

Compressed air from the suspension air tank is supplied to height control valves. Pressure regulator valve, however, allows removal of air from main tank only when pressure is above 65 psi. A check valve at suspension tank prevents loss of air back into main system. An air filter is connected in line at pressure regulator valve. Height control valves, one at front axle and two at rear axle, meter air into the bellows as needed. Valves are actuated by the relative movement between body and axles.

Loading. As coach is loading, the body settles toward axles. This movement operates height control valves and valves meter air into bellows. Air pressure in bellows increases sufficiently to compensate for the additional load. This keeps the coach body at normal ride height.

Unloading. As the coach is unloading, the height control valves exhaust air from the bellows. Valves reduce air pressure in proportion to the decrease in weight, again keeping the coach body at normal ride height.

The height control valves are designed to operate only when load on coach is increased or decreased. Valves do not respond to rapid relative motion between axles and body such as that caused by road bumps. Refer to "Height Control Valves" later in this section for a detailed description of height control valve operation.

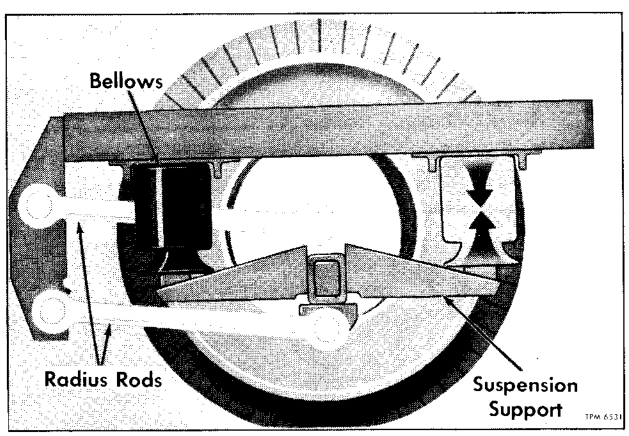


Figure 1—Sketch of Air Suspension System

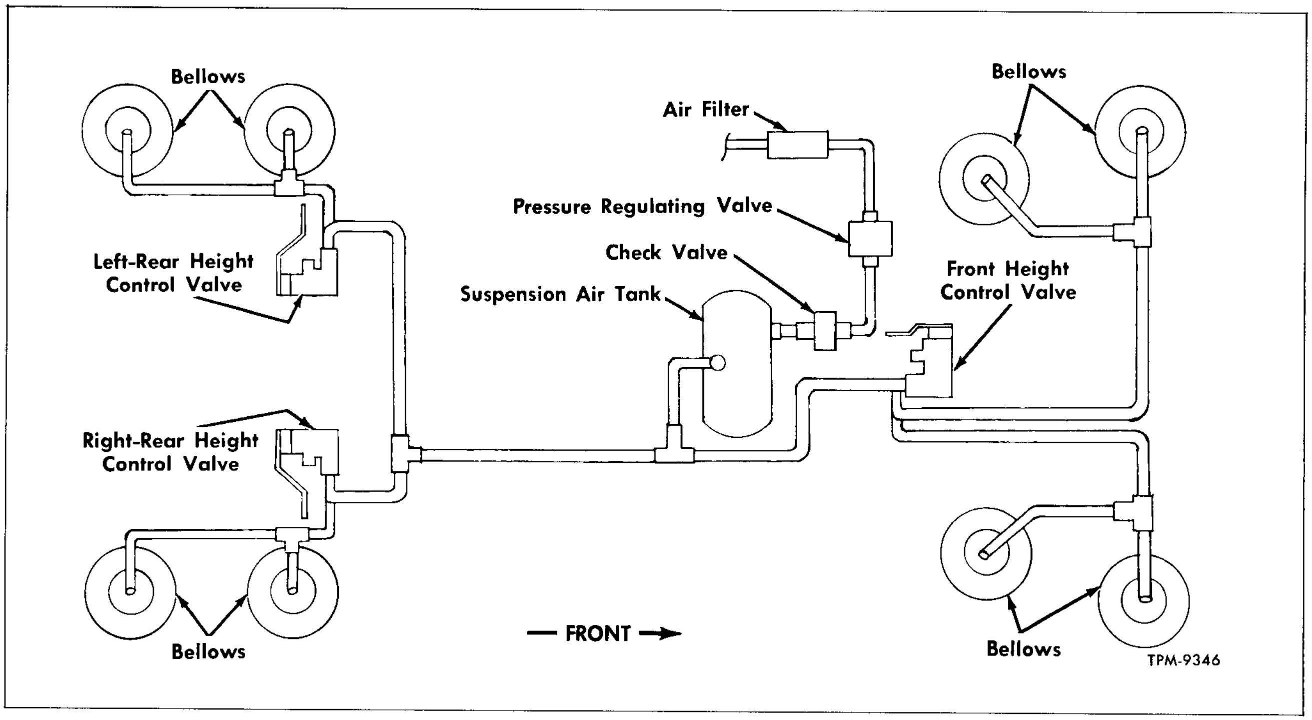


Figure 2—Schematic Diagram of Suspension Air System

SYSTEM MAINTENANCE

Air suspension system requires no lubrication, and with the exception of the inspection and test procedures outlined below, requires very little maintenance. By accomplishing these inspection and test procedures at established chassis inspection periods, sub-standard performance may be revealed before the condition becomes bad enough to cause operator complaints or failure on a run. Diagram of the suspension air system is shown in figure 2.

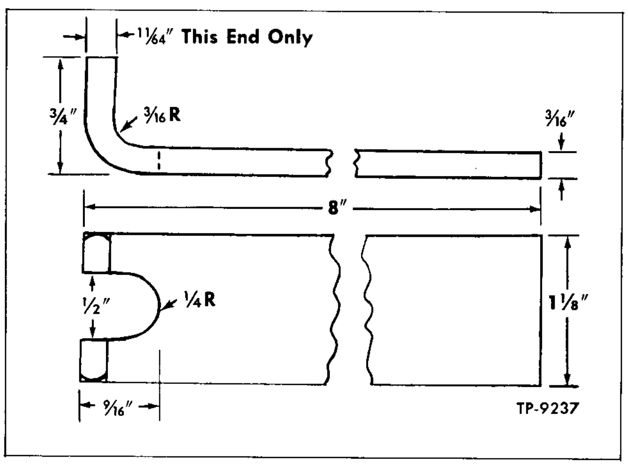


Figure 3—Special Tool For Drain Cock

CAUTIONS

1. Do not attempt to work under vehicle without first blocking body or placing vehicle over a pit. With air bellows deflated, there is not sufficient clearance under vehicle for a man on a creeper. When blocking body, place blocks under jack pads provided at front and at rear lower radius rod brackets. Jack pads are shown in figure 6.
2. Use no lubricant, not even water, on radius rod rubber bushings.
3. If necessary to tow vehicle with one end raised, axle must be chained to body. This is necessary since air pressure will be exhausted from bellows at the raised end. The weight of the axle hanging on the deflated bellows may damage bellows or shock absorbers. Chains can be secured around axle and through the axle bumper brackets.

AIR TANKS

Suspension air tank, as well as the main air tanks, must be drained daily to keep air system as free of moisture as possible. In cases of extreme cold weather, an alcohol evaporator should be installed to introduce alcohol vapor into the air system to prevent moisture from freezing. Two different type drain cocks are used on these air tanks. The conventional type with hand operated handle and a recessed-key type. A special tool (which can be made locally) must be used to open and close the recessed-key type drain cock. Di-

mensions for making this tool are shown in figure 3.

AIR LEAKAGE TEST

With the main air system at normal operating pressure (105-120 psi), coat all suspension air line connections and bellows mountings with soap and water solution. Air leakage will produce soap bubbles. No leakage is permissible. Leakage at air line connections can sometimes be stopped by tightening the connection. Where air line connections having rubber sleeves are used, replace rubber sleeve. If tightening mounting nuts does not stop leakage, remove and inspect bellows. Replace bellows, if necessary.

MOUNTING AND BELLOWS INSPECTION

Make a wrench check for loose suspension support stud and mounting bolt nuts, radius rod anchor bolts and nuts, shock absorber mountings, and height control valve mountings. Suspension support, radius rod, and shock absorber mountings must be tightened to torque listed in "Specifications" at end of this section. Visually inspect all bellows for cracks, abrasions, or other damage which might develop into a rupture. Replace with new bellows if any damage is evident. Piston surface should be smooth and free from cracks.

RIDE HEIGHT CHECK AND ADJUSTMENT

Normal operating pressure is 105-120 psi. At this pressure, height control valves will automatically meter air into or out of bellows as load changes.

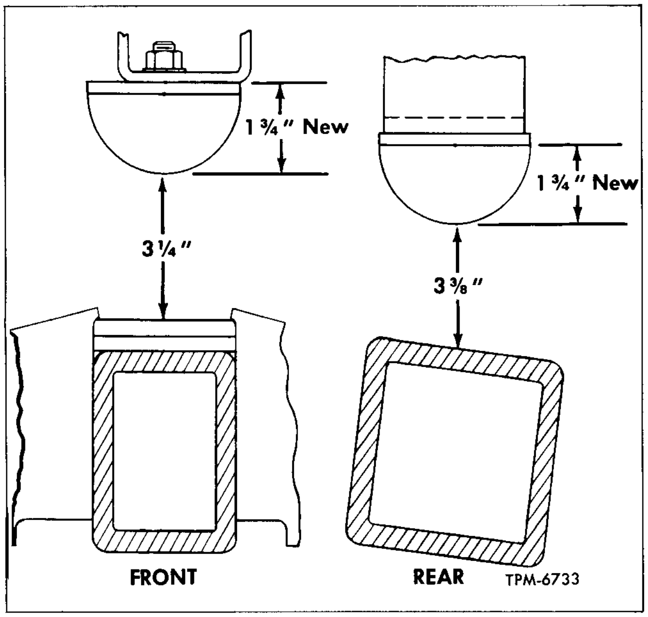


Figure 4—Normal Ride Height Clearance

Normal Ride Height. Ride height measurements are taken between axle bumpers and top of axle housing as shown in figure 4. Clearance between bumper and axle at front is 3-1/4", and at rear 3-3/8".

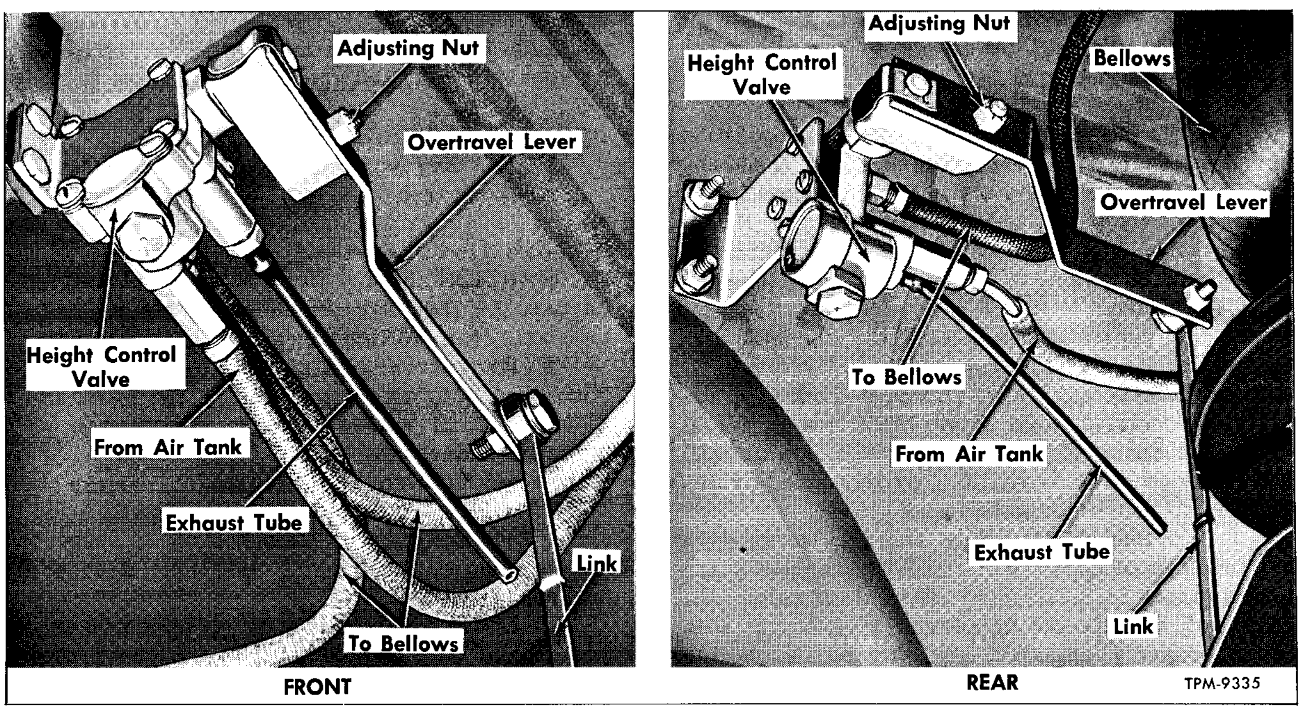
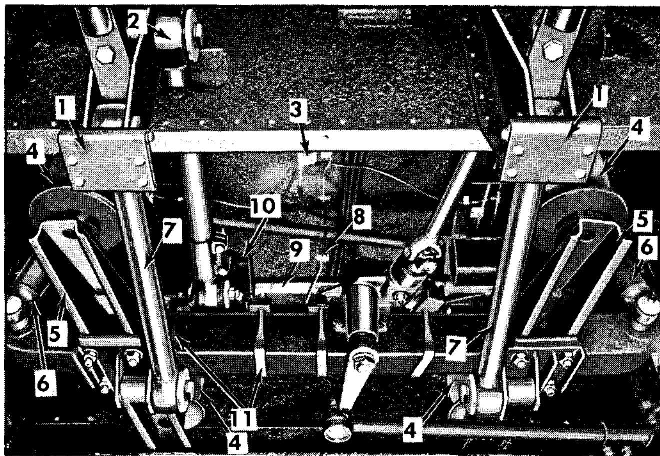
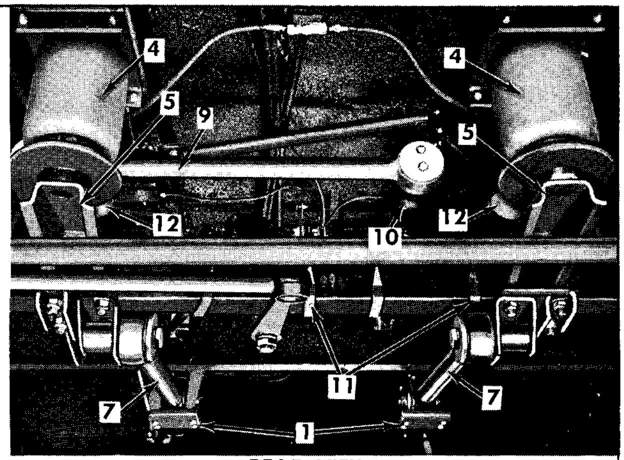


Figure 5—Height Control Valves Installed





FRONT VIEW		REAR VIEW
1 Jack Pad	5 Suspension Support	10 Upper Radius Rod Anchor Bracket
2 Radius Rod - Upper	6 Shock Absorber	11 Rod Anchor Bracket U-bolts
3 Height Control Valve	7 Radius Rod - Lower	12 Axle Rubber Bumper
4 Bellows	8 Height Control Valve Link	
	9 Radius Rod - Lateral	

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Figure 6—Front Axle and Air Suspension Installed

NOTE: Normal ride height clearance dimensions given are based on the thickness of new axle bumpers (fig. 4). If coach is left standing for extended periods without air pressure in the air suspension system, the weight of the body on the axle bumpers may cause the bumpers to take a permanent set in a flattened condition. Original thickness of new bumpers is shown in figure 4. If bumpers are flattened to less than the dimension shown, an equal amount should be added to the clearance specified to maintain normal ride height.

Overtravel Lever Adjustment. Change position of valve lever on overtravel assembly, if necessary, to obtain the above dimensions. Position of the lever may be changed by loosening nut (fig. 5) on adjusting bolt. Intake and exhaust valves of height control valve can then be operated independently of linkage.

Height control valve lever will move 3/16 inch up or down from neutral position (free travel) without causing any valve action. If amount of adjustment required falls within these limits, adjust lever the required amount. However, frame will not raise or lower until load is increased or decreased to actuate height control valve.

If any one of the height control valves does not function properly with the lever correctly adjusted, check for restricted air lines. If valve still does not hold frame at normal ride height with lever properly adjusted, and with no restriction in air line, valve should be removed and overhauled or replaced with a new or rebuilt unit. Refer to "Height Control Valves" later in this section.

FRONT AXLE AND FRONT SUSPENSION REMOVAL

The procedures which follow cover removal of front axle assembly and suspension components. Procedures also cover removal of suspension components from axle assembly. Method used to support axle and suspension units during removal and disassembly depends upon local conditions and available equipment. Front axle and air suspension components installed are shown in figure 6.

REMOVAL PROCEDURE

NOTE: Key numbers in text refer to figure 6.

1. Block rear wheels to prevent coach from rolling. Position a hydraulic floor jack under each lower radius rod bracket.

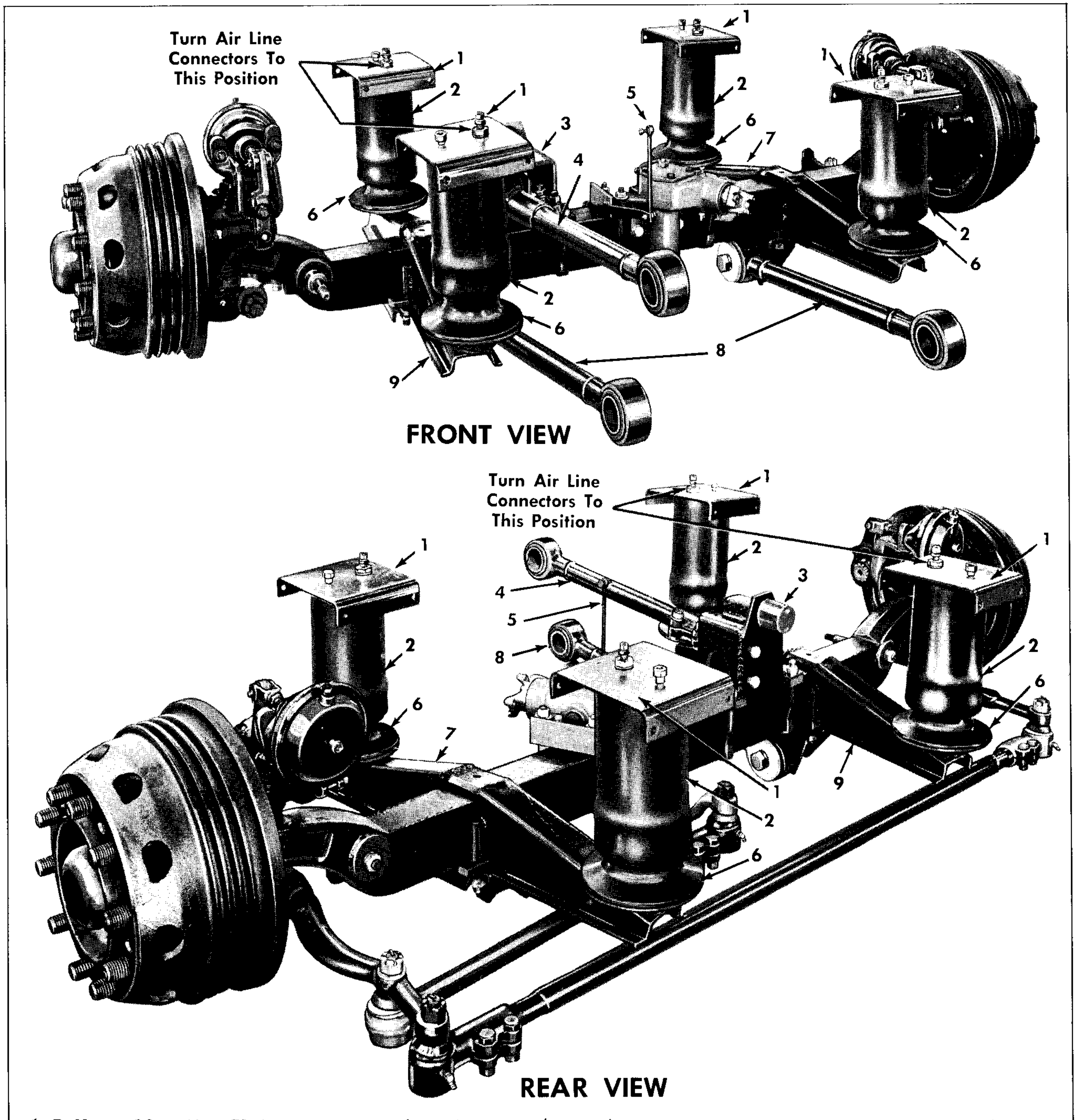
CAUTION: Blocks or special adapters should be used on jack lifts in a manner which will prevent axle from rolling off jacks when disconnected.

2. Raise front end of vehicle with jacks until bottom of body is approximately 18" from floor. Block body in raised position. Place each block directly under jack pads (1) provided at lower radius rod front anchor brackets.

IMPORTANT: Do not raise body with hoist or chain fall and permit axle to hang unsupported. The weight of the hanging axle may damage the bellows.

3. Lower jacks until body rests on blocks, but with jacks still supporting axle. Remove wheels and tires. Carefully swing ends of jacks out from under vehicle to provide free working area.

4. Exhaust compressed air from air supply



1 Bellows Mounting Plate
2 Bellows
3 Upper Radius Rod Mounting Bracket
4 Radius Rod (Upper)
5 Height Control Valve Link
6 Bellows Piston
7 Suspension Support (L.H.)
8 Radius Rod (Lower)
9 Suspension Support (R.H.)

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Figure 7—Front Axle and Suspension Components Assembled

system by opening drain cock in suspension air tank.

5. Disconnect steering gear drive shaft rear universal joint from steering gear.

6. Disconnect height control valve link (8) from bracket attached to steering gear support. Pull down on height control valve lever to exhaust compressed air from bellows.

7. Remove lock nuts from bolts attaching bellows mounting plates to brackets on body beam.

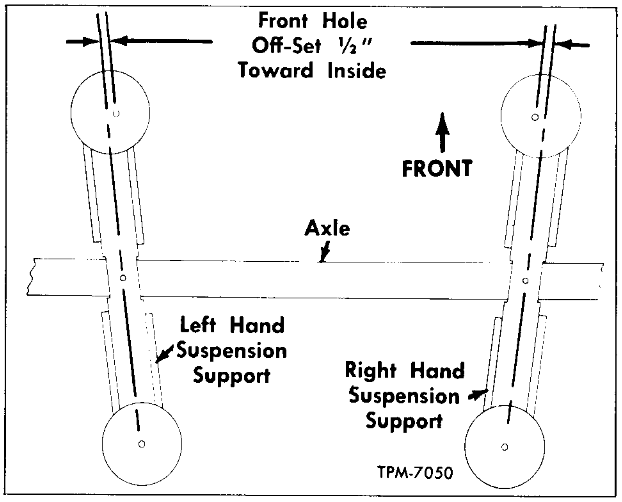


Figure 8—Front Suspension Support Position

8. Disconnect hoses from brake chambers, and air lines from bellows.

9. Disconnect both ends of lower radius rods (7), and upper and lateral radius rods (2, 9). Refer to "Radius Rods" later in this section.

10. Disconnect stabilizer bar (on those models using such assemblies). Refer to "Stabilizer Bar" later in this section.

11. Remove shock absorbers as directed in "Shock Absorbers" later in this section.

12. Lower axle on jacks until bellows mounting plates are clear of brackets and axle will clear underside of coach. Carefully pull jacks and axle assembly from under coach.

REMOVAL OF SUSPENSION COMPONENTS

NOTE: Key numbers in text refer to figure 7.

1. Support axle in such a position so that suspension supports may be removed easily.

2. Remove four nuts securing lower radius rod bracket on suspension support studs. Remove bracket from studs. Lift suspension support off top of axle.

3. Remove nuts from two U-bolts attaching upper radius rod bracket (3) to axle. Remove U-bolts and bracket.

FRONT AXLE AND FRONT SUSPENSION INSTALLATION

Assemble suspension units to axle as illustrated in figure 7, before moving axle under coach. The method used to support axle and suspension supports is dependent upon local conditions and available equipment. Key numbers in text refer to figure 7.

1. Install each suspension support (7, 9) on axle with hole in support over locating pin in axle. Supports are not interchangeable. When supports are properly installed, plate holes will be in position shown in figure 8.

2. Install brackets under axle on support studs. Bracket should fit down over locating pin so that radius rod anchor pin will be toward inside. Install washers and nuts and tighten to torque listed in "Specifications" at end of this section.

3. Place upper radius rod bracket (3) in position over locating pin on axle. Lateral radius rod anchor pin on bracket will be at rear of axle. Attach bracket to axle with two U-bolts and four nuts. Tighten nuts to torque listed in "Specifications" at end of this section.

INSTALLATION PROCEDURE

NOTE: Key numbers in text refer to figure 7.

1. If removed from suspension supports, bellows assemblies should be installed before axle is moved back under coach. Place each bellows assembly in position on suspension support and attach nut loosely on bellows lower stud. Place front and rear mounting plates on bellows assemblies as shown in figure 7. Front plates should have the larger of two holes toward the inside. Rear plates should have large hole at front. Rotate bellows assembly, if necessary, to align upper retainer studs with holes in plate. Install large nut and lock washer and small lock nut on each bellows. Tighten nuts to torque listed in "Specifications" at end of this section.

2. Position axle on two hydraulic floor jacks, with one jack lift under each lower radius rod axle bracket.

CAUTION: Blocks or special adapters should be used on jack lifts to prevent axle from falling off jacks.

3. Carefully move axle into position under coach. Lift axle and align bellows mounting plates with beam brackets. Plates should seat solidly against beams.

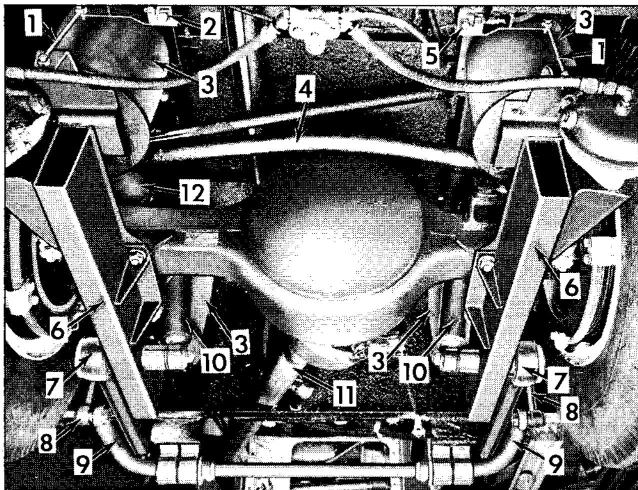
4. Connect upper radius rod (4) and lateral radius rod to anchor brackets. Refer to "Radius Rods" later in this section. Do not tighten cap screws or mounting bolt nut.

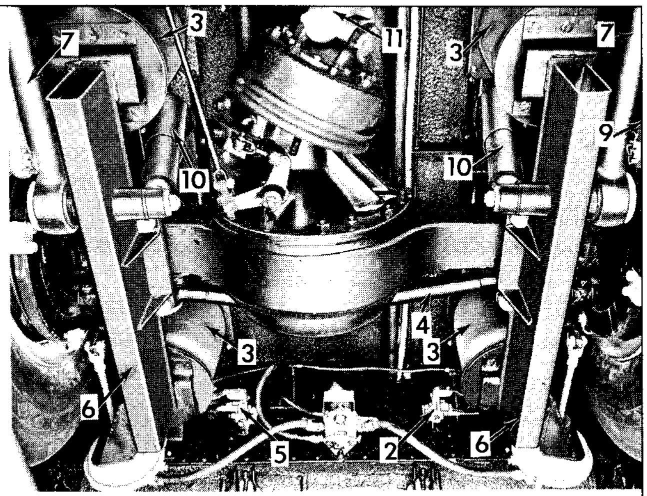
5. Insert four bolts from bellows side into mounting plates at each bellows and install four lock nuts. Tighten mounting bolt nuts and lower mounting stud nuts to torque listed in "Specifications" at end of this section.

6. Install lower radius rods (8). Refer to "Radius Rods" later in this section. Do not tighten cap screws or mounting bolt nuts.

7. Install shock absorbers as directed under "Shock Absorbers" later in this section.

8. Position each end of axle by raising or lowering jacks to provide a clearance of 3-1/4" (normal ride height) between axle bumper and contact surface on suspension support (fig. 4). Refer to "NOTE" under "Ride Height Check and Adjustment"





FRONT VIEW | REAR VIEW

1 Height Control Valve Link
2 Height Control Valve (R.H.)
3 Bellows
4 Radius Rod - Lateral
5 Height Control Valve (L.H.)
6 Suspension Support
7 Radius Rod - Lower
8 Stabilizer Bar Link
9 Stabilizer Bar
10 Shock Absorber
11 Propeller Shaft
12 Axle Rubber Bumper

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Figure 9—Rear Axle and Air Suspension Installed

earlier in this section. With axle in normal ride height position, tighten radius rod cap screws and anchor bolt lock nuts to torque listed in "Specifications" at end of this section. Thread lock wire through cap screws and twist ends of wire together.

9. With axle still in normal ride height position (step 8 above), connect height control valve link (5) to height control valve.

10. Connect steering gear drive shaft to steering gear on axle.

11. Connect flexible hoses to each brake chamber. Make sure connections are tight. Connect air lines to bellows. Replace rubber sleeves if deteriorated or damaged.

12. On those models where used, install stabilizer bar and links as directed under "Stabilizer Bar" later in this section.

13. Swing jacks under vehicle to permit installation of wheels. Install wheels.

14. Raise coach and remove blocks from under body. Lower vehicle to floor and remove jacks. Build up air pressure in system to normal operating pressure. Wait a few minutes for air to flow into suspension system, then check clearance between axle bumpers and suspension supports (fig. 4). If clearance is appreciably more or less than 3-1/4", adjust overtravel lever on height control valve as necessary to obtain this dimension. Refer to "Ride Height Check and Adjustment" earlier in this section. Make sure lever adjusting nut is tight when adjustment is completed.

15. Check for air leakage at all bellows upper and lower mountings. Coat mountings with soap and water solution and watch for appearance of soap bubbles. No leakage is permissible. If leakage is evident, bellows must be disconnected and mating surfaces must be cleaned. Bellows must be replaced if bead is damaged.

REAR AXLE AND REAR SUSPENSION REMOVAL

The procedures which follow cover removal of rear axle assembly and suspension components. Procedures also cover removal of suspension components from axle assembly. Method used to support axle and suspension units during removal and disassembly depends upon local conditions and available equipment. Rear axle and air suspension units installed are shown in figure 9.

REMOVAL PROCEDURE

NOTE: Key numbers in text refer to figure 9.

1. Block front wheels to prevent coach from rolling. Position a hydraulic floor jack under center of each suspension support.

CAUTION: Jack lifts should be equipped with large bowls, or similar precautions should be taken to prevent axle from rolling off jacks when disconnected.

2. Raise rear end of vehicle with jacks until bottom of body is approximately 18" from floor. Block body in raised position. Make sure blocks are placed directly under jack pads at lower radius rod body brackets.

IMPORTANT: Do not raise body with hoist or

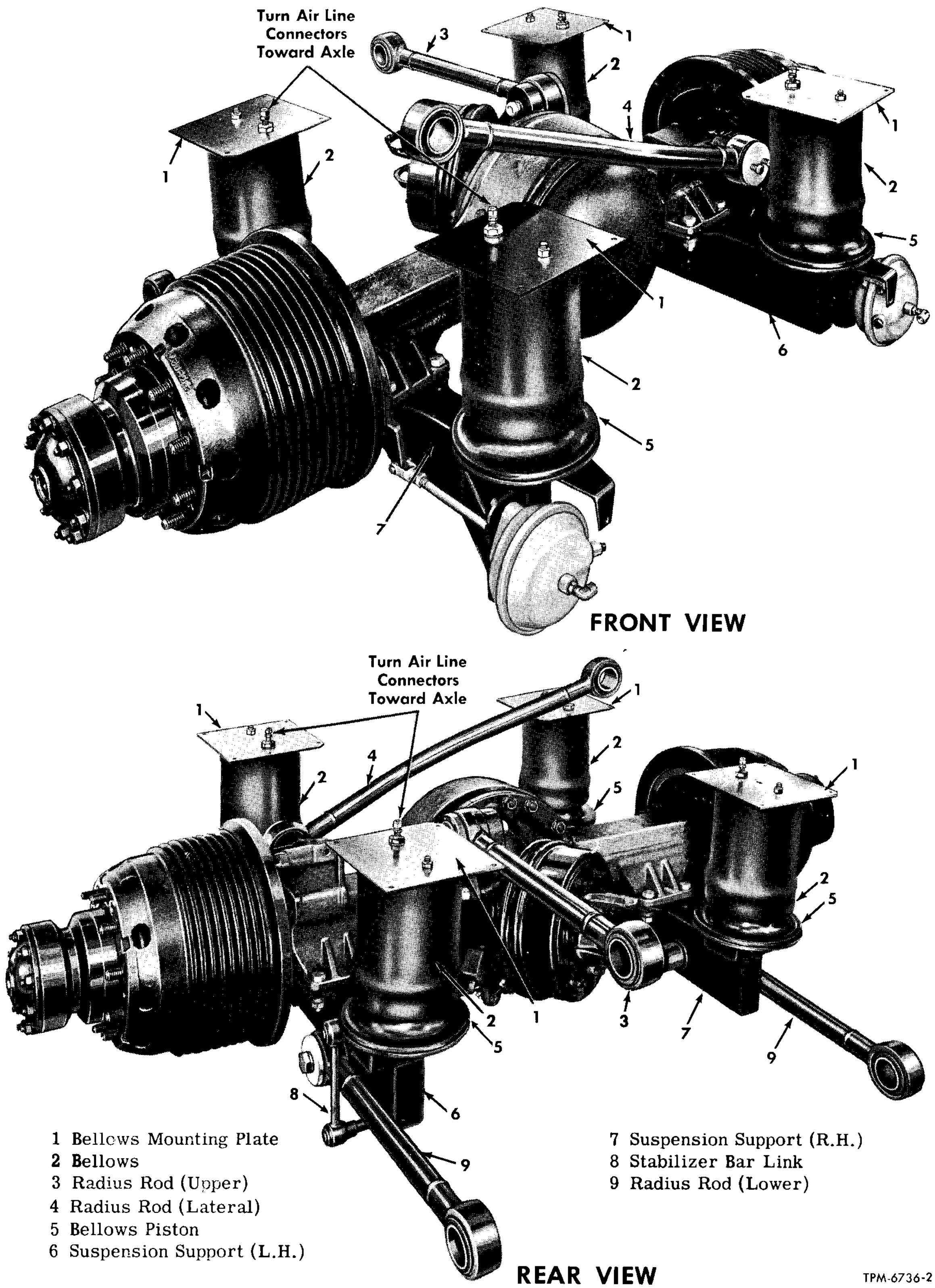


Figure 10—Rear Axle and Suspension Supports Assembled

chain fall and permit axle to hang unsupported. The weight of the axle will damage the bellows.

3. Lower jacks until body rests on blocks, but with jacks still supporting axle. Remove wheels and tires. Carefully swing jacks out from under vehicle to provide free working area.

4. Exhaust compressed air from air supply system by opening drain cock in suspension air tank.

5. Disconnect propeller shaft (11) and parking brake control rod from axle.

6. Disconnect height control valve links (1) from overtravel levers. Pull down on each height control valve lever to exhaust compressed air from bellows (3).

7. Remove four bolts and lock nuts attaching each bellows mounting plate to plate on coach body beam.

8. Disconnect flexible hoses from brake chambers, and air lines from bellows.

9. Disconnect stabilizer bar (9). Refer to "Stabilizer Bar" later in this section.

10. Remove lower (7), upper, and lateral (4) radius rods. Refer to "Radius Rods" later in this section.

11. Remove shock absorbers (10) as directed under "Shock Absorbers" later in this section.

12. Lower axle on jacks until bellows will clear underside of vehicle. Carefully pull jacks and axle assembly from under vehicle.

REMOVAL OF SUSPENSION SUPPORTS

NOTE: Key numbers in text refer to figure 10.

1. Support axle assembly so that suspension supports (6, 7) may be removed safely from axle.

2. Remove brake chambers and stabilizer bar links (8) from suspension supports.

3. Remove two lock nuts from studs at bottom of each bellows assembly. Remove bellows assembly from suspension support.

4. Remove four nuts, spacers, and bolts attaching each suspension support to axle housing. Remove suspension support.

REAR AXLE AND REAR SUSPENSION INSTALLATION

ASSEMBLY OF AXLE AND SUSPENSION SUPPORTS

Assemble suspension units to axle before moving axle under coach as illustrated in figure 10. Radius rods, however, should be installed after axle is in position. The method used to support axle and suspension supports is dependent upon local conditions and available equipment. Tighten all studs, bolts, and nuts to torque listed in "Specifications" at end of this section. Key numbers in text refer to figure 10.

1. Position each suspension support (6, 7) under axle. Radius rod and shock absorber anchor pins on supports should be on the parking brake side of the axle. Attach support to axle with four bolts, spacers, and nuts. Tighten nuts to torque listed in "Specifications" at end of this section.

2. Attach brake chambers and stabilizer bar links (8).

3. Position each bellows assembly on suspension support so that fitting at top will be toward axle. Place lock nuts on two mounting studs and tighten nuts to torque listed in "Specifications" at end of this section.

INSTALLATION PROCEDURE

NOTE: Key numbers in text refer to figure 9.

1. Center a hydraulic floor jack under each suspension support.

CAUTION: Jack lifts should be equipped with large bowls, or similar precautions should be taken to prevent axle from rolling off jacks when disconnected.

2. Carefully move jacks and axle assembly into position under coach. Lift axle and align plate on each bellows assembly with plate on beams.

3. Connect flexible hose to brake chambers. Make sure connections are tight. Connect air lines to bellows. Replace rubber sleeves if deteriorated or damaged.

4. Attach each plate with four bolts and lock nuts. Tighten lock nuts to torque listed in "Specifications" at end of this section.

5. Install shock absorbers (10) as directed under "Shock Absorbers" later in this section.

6. Connect lateral (4) upper, and lower (7) radius rods. Refer to "Radius Rods" later in this section. Do not tighten cap screws or lock nuts at this time.

7. Raise or lower jacks to provide an axle clearance of 3-3/8" (normal ride height) between rubber axle bumpers and axle as shown in figure 4. Refer to "NOTE" under "Ride Height Check and Adjustment" earlier in this section. With axle in normal ride height position, tighten radius rod cap screws and anchor bolt lock nuts to torque listed in "Specifications" at end of this section. Thread lock wire through cap screws and twist ends of wire together.

8. With axle still in normal ride height position (step 7 above), connect height control valve links (1) to valves.

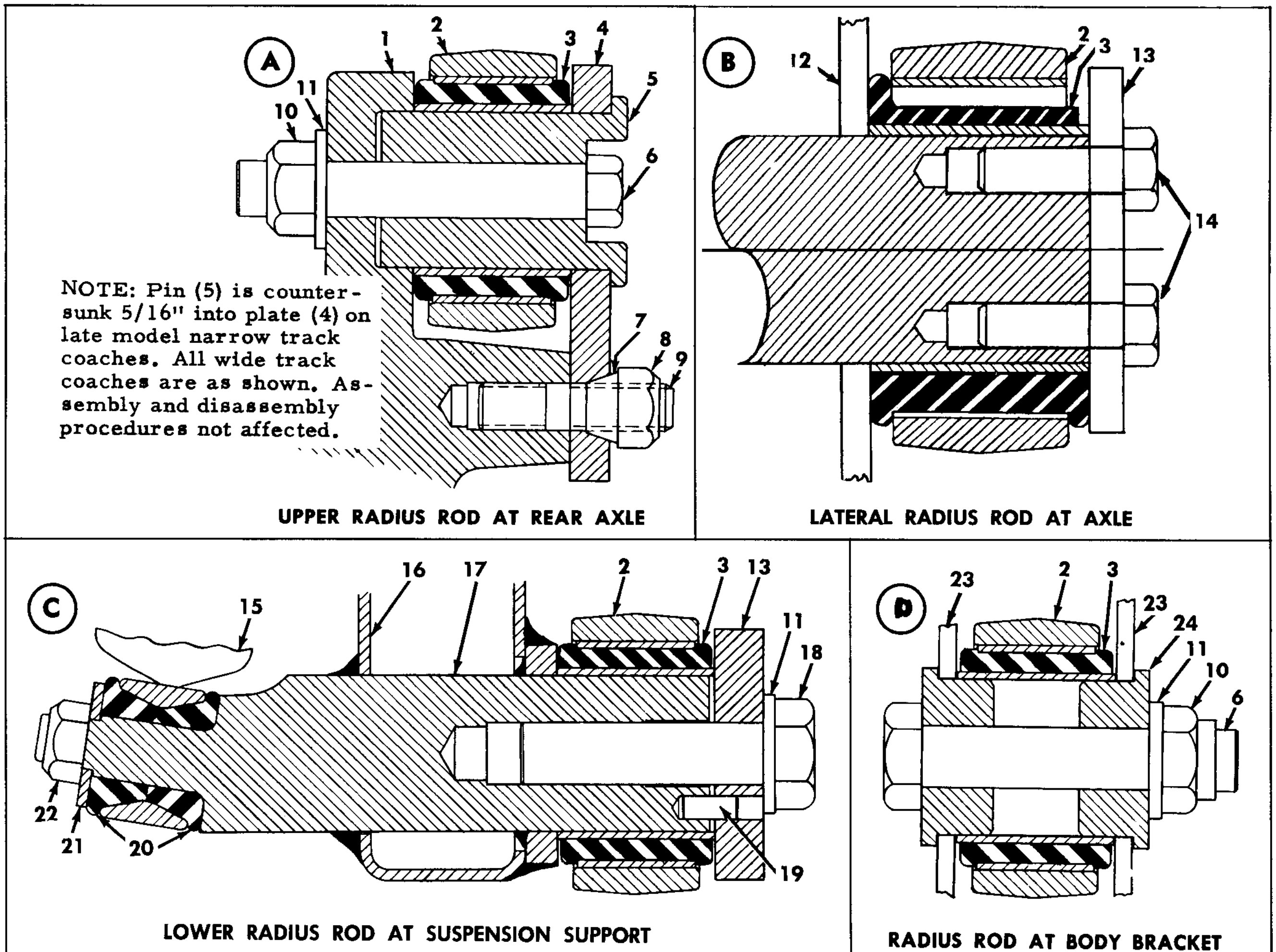
9. Connect propeller shaft (11) and parking brake linkage to axle.

10. Install stabilizer bar (9) and links (8) as directed under "Stabilizer Bar" later in this section.

11. Swing jack out of the way under coach and install wheels and tires.

12. Raise coach with jacks and remove blocks from under body. Lower vehicle to floor and remove jacks. Build up air pressure in system to

AIR SUSPENSION



1 Differential Carrier
2 Radius Rod
3 Rod Bushing
4 Anchor Plate
5 Anchor Pin
6 Anchor Bolt
7 Anchor Plate Stud Dowel
8 Anchor Plate Stud Nut
9 Anchor Plate Stud
10 Anchor Bolt Nut
11 Anchor Bolt Washer
12 Lateral Rod Bracket
13 Retaining Washer
14 Lateral Rod Cap Screw
15 Shock Absorber
16 Suspension Support
17 Anchor Pin
18 Bolt
19 Dowel Pin
20 Shock Absorber Bushing
21 Shock Absorber Mounting Washer
22 Shock Absorber Mounting Nut
23 Body Bracket
24 Anchor Washer

TPM-9569

Figure 11—Radius Rod End Mountings

normal operating pressure. Wait a few minutes for air to flow into bellows, then check clearance between axle bumpers and axle (fig. 4). If clearance is appreciably more or less than 3-3/8", adjust overtravel lever on each height control valve as necessary to obtain this dimension. Refer to "Ride Height Check and Adjustment" earlier in this section. Make sure lever adjusting nut is tight when adjustment is completed.

13. Check for air leakage at all bellows upper and lower mountings. Coat mountings with soap and water solution and watch for appearance of soap bubbles. No leakage is permissible. If leakage is evident, bellows must be disconnected and mating surfaces must be cleaned. Bellows must be replaced if bead is damaged.

RADIUS RODS

Radius rods are hollow steel tubes with steel forgings welded at each end. The front upper radius rod, however, has threads on axle end of tube and on forging, to provide an adjustment for front axle caster. These parts thread into a split clamp and are locked in place by two bolts, nuts, and lock washers.

Rear axle upper and lower radius rods are all interchangeable, and front axle lower radius rods are interchangeable. Radius rods are not interchangeable, however, between front and rear axles. Radius rod connections at axle and at body are illustrated in figure 11. These connections are typical for both front and rear rods.

RADIUS ROD REPLACEMENT (Fig. 11)

The following procedures include instructions for disconnecting and connecting radius rods at body and at axles. Lower radius rods must be disconnected at body before axle end can be removed from anchor pin. Raise body just enough to remove weight from air bellows and block in position before disconnecting radius rods. Refer to "Caution" at beginning of this section.

IMPORTANT: When any radius rod has been disconnected, correct clearance between axle bumpers must be obtained before tightening anchor bolts or cap screws. If connections are tightened without first obtaining this clearance, a torsional preload will be imposed on the rubber bushings when the body assumes normal ride height relative to the axles. Follow instructions under "Tighten Bolts, Nuts, and Cap Screws" (step 10 following).

1. Disconnect Radius Rod at Body (All Except Front Lateral. Remove nut from anchor bolt (D, fig. 11). Remove anchor bolt and anchor washers.

2. Disconnect Front and Rear Lateral Radius Rod at Axle and Front Rod at Body. Remove two cap screws and washer. Pull radius rod off anchor pin (C, fig. 11).

3. Disconnect Lower Radius Rods at Axle. Remove bolt and washer. Remove large washer from dowel pin. Pull radius rod off suspension support (C, fig. 11).

4. Disconnect Upper Radius Rods at Axle. Front radius rod may be disconnected at front axle by following step 1 (D, fig. 11) above. To disconnect rear radius rod at axle, remove two anchor plate stud nuts and two anchor plate stud dowels (A, fig. 11). Remove anchor bolt nut and anchor bolt washer. Remove anchor bolt, anchor pin, anchor plate, and radius rod.

5. Inspection. Clean all parts thoroughly. Inspect radius rods for bent condition and for evidence of cracks. Inspect bushings for signs of shearing, deterioration, or other damage. Any damaged part should be replaced with a new part.

When replacing, position split in bushing approximately 90° to center-line of rod. Spaces between four rubber lobes of lateral radius rod bushing should be centered on horizontal and on vertical center-lines of rod end. Press in until bushing is centered in rod end. Use no lubricant, not even water, on rubber bushings.

6. Connect Lower Radius Rods at Axle. Place radius rod end over anchor pin. Position large washer and install bolt. Tighten bolt finger tight (C, fig. 11).

7. Connect Upper Radius Rod at Axle. Position upper radius rod in front axle bracket and on anchor pin at body end (after installing spacer) and install anchor washers, anchor bolt, and anchor bolt nut (D, fig. 11). Tighten nut finger tight.

Connect upper rod at rear axle as follows: Place anchor plate over studs in differential carrier (A, fig. 11). Attach with two anchor plate stud dowels and two anchor plate stud nuts. Leave nuts loose. Position radius rod end and insert anchor pin and anchor bolt. Install anchor bolt washer and nut. Leave nut loose.

8. Connect Radius Rod at Body (All Except Front Lateral). Place end of radius rod in position. Install anchor washers, anchor bolt, anchor bolt washer, and anchor bolt nut (D, fig. 11). Tighten nut finger tight.

9. Connect Front and Rear Lateral Radius Rods at Axle and Front Rod at Body. With rod end

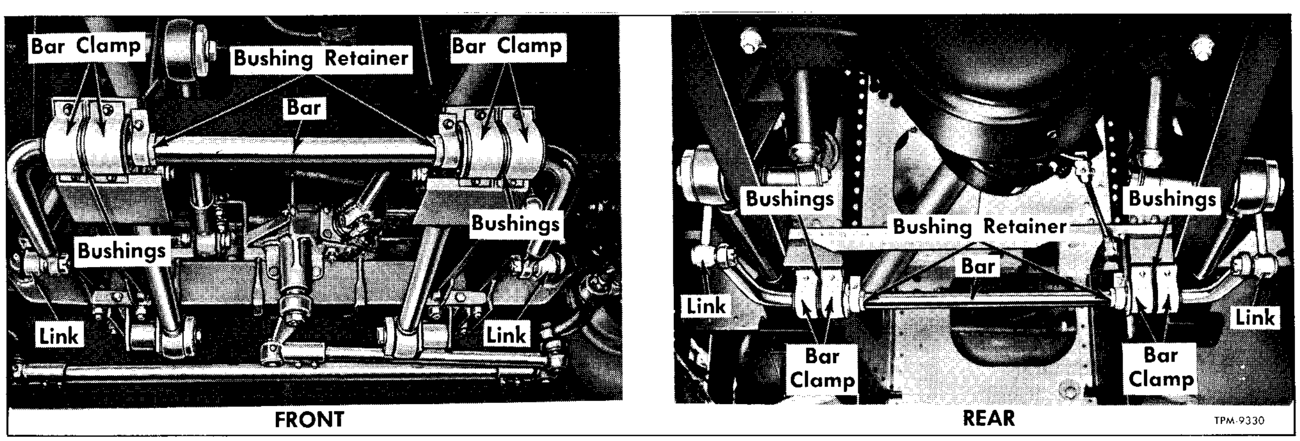


Figure 12—Stabilizer Bar Installed

already on anchor pin, position washer and install two cap screws. Tighten cap screws finger tight (B, fig. 11).

10. Tighten Bolts, Stud Nuts and Cap Screws. Refer to "Ride Height Check and Adjustment" earlier in this section for instructions on obtaining normal ride height clearance between axle bumpers and axles. After correct clearance is obtained, tighten bolts, nuts, and cap screws to torque listed in "Specifications" at end of this section. Thread lock wire through cap screws at axle and twist ends of wire together. Remove blocks and jacks from under vehicle.

STABILIZER BAR

Certain model coaches have both front and rear stabilizer bar assemblies. Front stabilizer bar is attached to front radius rod bracket adjacent to the jack pad (fig. 12).

Rear stabilizer bar is anchored to brackets on coach body bulkhead at rear axle (fig. 12). Bar helps to control vehicle stability. Rubber bushed clamps anchor bar firmly to brackets while links at each end of bar are attached to suspension supports. A retainer on bar is clamped flush against each inner rubber bushing. Instructions for removal and installation of stabilizer bar applies to both front and rear.

REPLACEMENT

Removal

1. Remove cotter pins and nuts from link ball studs. Discard cotter pins. Remove both stabilizer bar links.

2. Support bar and remove bolts from bar clamps at each side. Remove clamps, stabilizer bar, and rubber bushings. Loosen clamp nut and move each bushing retainer aside, if necessary.

Installation

1. Space bushings properly and place stabilizer bar in position under coach. While supporting bar, loosely attach a bar clamp around each bushing with bracket bolt nuts.

2. Wipe all grease, oil, or foreign matter from link stud tapers and from tapered holes.

NOTE: To avoid a preload on link stud rubber mountings, install links when vehicle is at normal ride height. Refer to "Ride Height Check and Adjustment" earlier in this section.

Install links and secure with nuts. Tighten clamp bolt nuts and link stud nuts to torque listed

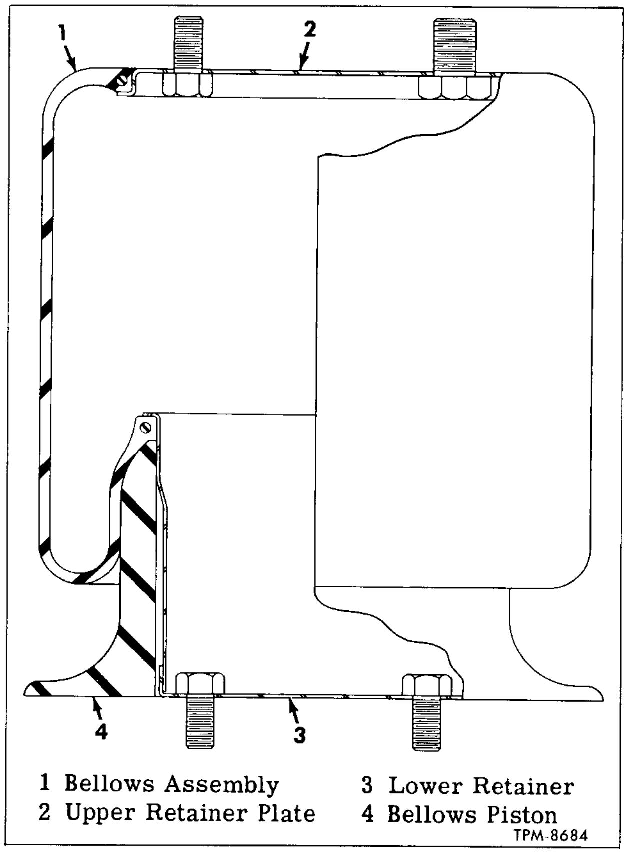


Figure 13—Sectional View of Air Bellows—Goodyear

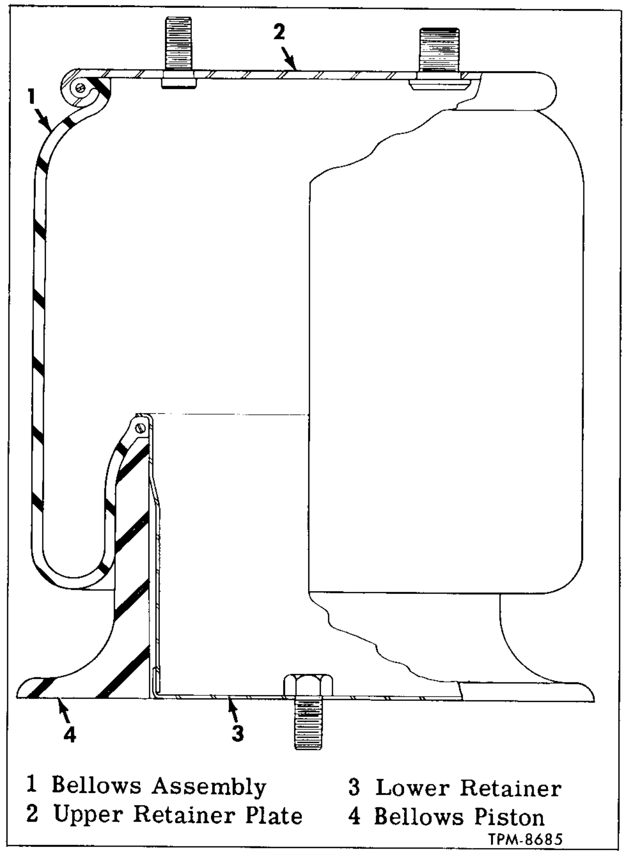


Figure 14—Sectional View of Air Bellows—Firestone

in "Specifications" at end of this section. Advance each link stud nut to meet cotter pin slot and install new cotter pins.

3. If bushing retainers have been removed, place two halves around bar and against inside of rubber bushing. Slip retainer clamp over assembly and tighten nut to torque listed in "Specifications" at end of this section.

AIR BELLOWS

Four "rolling lobe" type bellows made of rubberized nylon fabric are mounted at each axle (figs. 7 and 10). These "air cushions" provide the flexibility between axles and coach body. At the same time, the bellows retain the compressed air which supports the body.

The square bead at each end of bellows is reinforced with wire. The opening at piston end (bottom) is smaller than opening at top. Top bead is clamped between upper retainer and mounting plate. Bottom bead is clamped between lower retainer and upper edge of piston as shown in figure 13 and 14. When bellows are inflated, beads form air-tight seals. In operation, the bellows folds down over piston, taking a lobe-shaped contour. One of the studs in upper retainer is drilled and threaded for an air line connection.

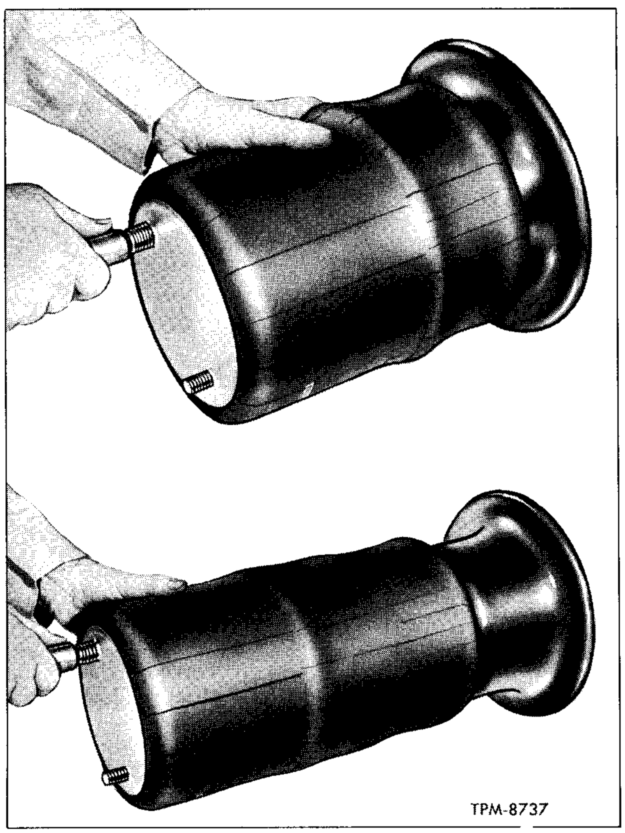


Figure 15—Removing Bellows Loop With Air Pressure

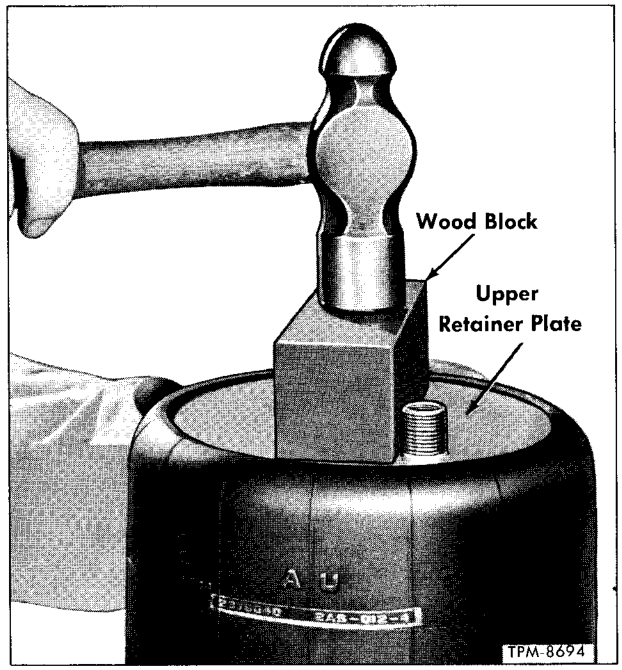


Figure 16—Loosening Retainer Plate From Bellows Bead

REMOVAL

1. Securely support coach body by placing blocks under body at points indicated for respective axle and suspension removal procedure.

Figure 17—Removing or Installing Upper Retainer Plate

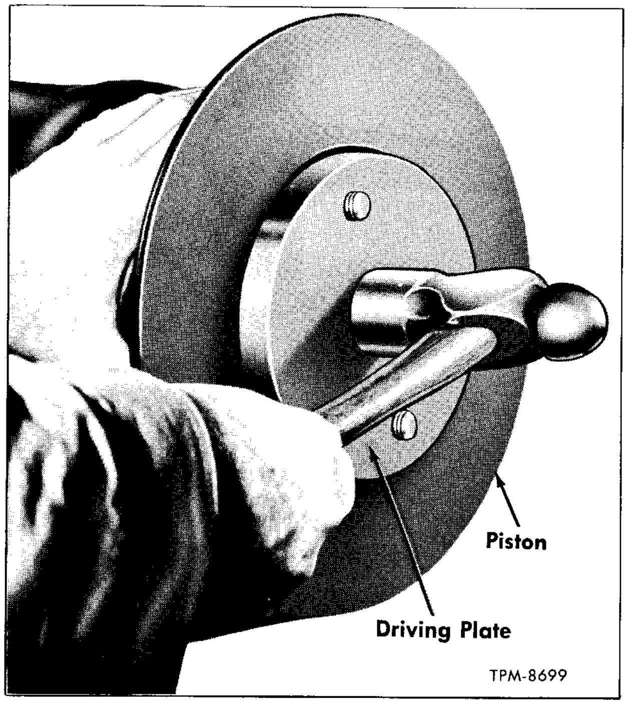


Figure 18—Removing Lower Retainer From Piston

2. If system is pressurized, disconnect height control valve link (one at front and two at rear), then pull down height control valve overtravel lever to exhaust air from bellows. Do not change height control valve lever adjustment.

3. Remove four nuts and bolts attaching mounting plate to beam. Remove lock nut from stud at bottom of bellows assembly (one stud on each front bellows, two studs on each rear bellows). Collapse bellows to get clearance, then disconnect air line and remove bellows assembly.

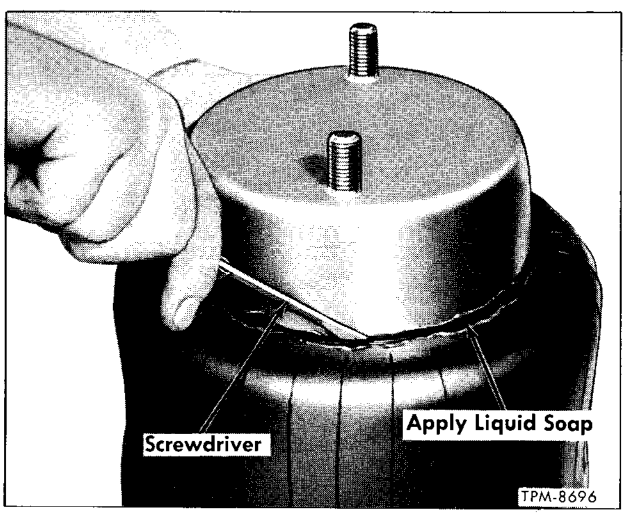


Figure 19—Loosening Bellows Bead From Lower Retainer

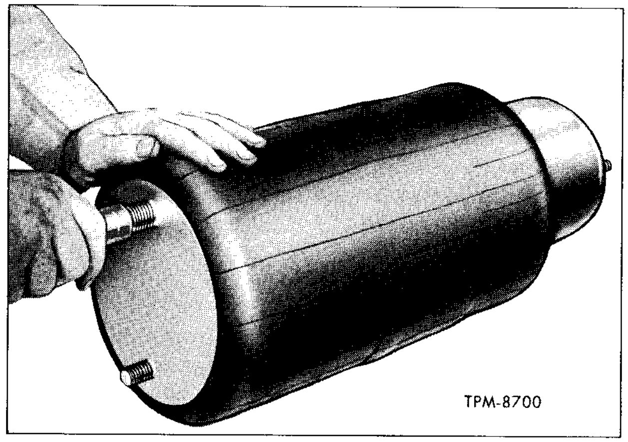


Figure 20—Seating Retainers In Bellows With Air Pressure

4. Remove nut and lock washer from large stud and remove nut from small stud attaching

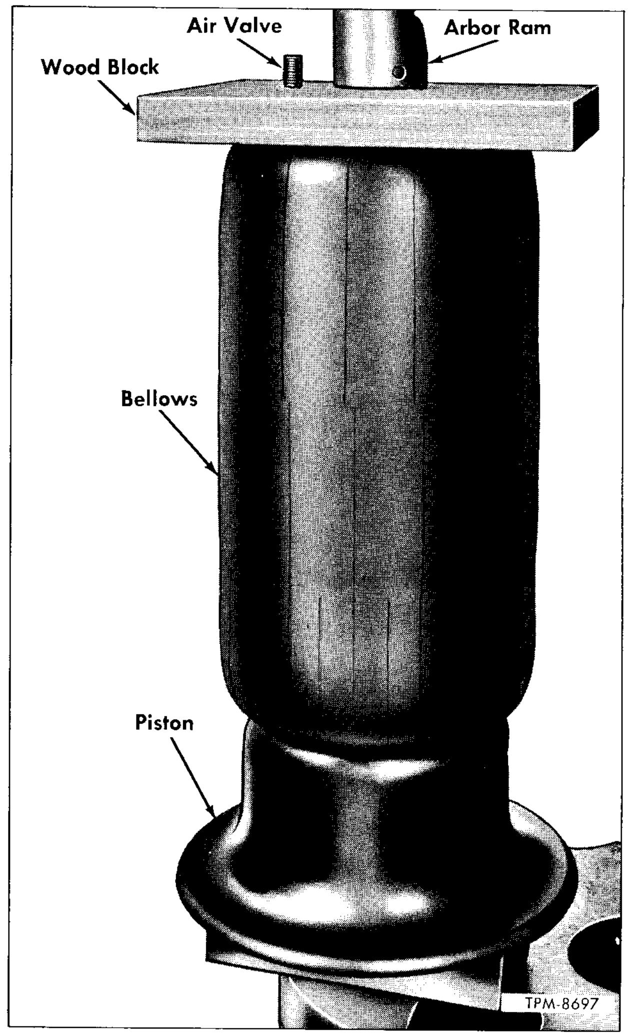


Figure 21—Forming Bellows Loop over Piston Using Arbor Press

mounting plate to upper retainer. Remove mounting plate.

DISASSEMBLY

NOTE: Bellows assembly shown in figure 14 can only be partially disassembled, therefore only paragraphs 1 and 4 are applicable to Firestone bellows.

1. With bellows assembly on bench, apply air through hollow fitting in upper retainer (fig. 15) until loop or fold is removed and bellows is straight.
2. Place wood block across upper retainer, then drive with hammer (fig. 16) until retainer is loose from bellows bead.
3. Press bellows to elongate opening, in order that upper retainer can be removed (fig. 17).
4. In many instances it will be necessary to drive lower retainer out of bellows. A locally made driving plate installed over end of retainer will prevent damage to retainer as it is driven from piston, as illustrated in figure 18.
5. Apply liquid soap or glycerine to lower retainer surface at point of bellows contact (fig. 19). Force screwdriver between retainer and bellows bead (fig. 19) to allow fluid to reach bellows bead.
6. When bead is loosened around entire surface of retainer, the retainer can be forced into bellows and removed through upper opening.

INSPECTION

Examine bellows inside and out for evidence of cracks, punctures, deterioration, or chafing. Replace with new bellows if any damage is evident. Any surface on upper and lower retainers or on piston that touches bellows should be smooth and free of cracks that might cause breaks or damage bellows. Check threads on studs. Replace any damaged parts.

ASSEMBLY

NOTE: Bellows assembly shown in figure 14 can only be partially disassembled, therefore paragraphs 1 through 3 are not applicable to Firestone bellows.

1. Install lower retainer assembly through bellows upper opening and into lower opening.
2. Install upper retainer in place in bellows, being sure that studs in upper retainer are at right angle to studs in lower retainer.
3. Apply air in bellows through opening in upper retainer stud (fig. 20) to seat lower and upper retainers in bellows.
4. Install piston over lower retainer.
5. Install air supply valve in upper retainer stud, then inflate bellows to 5 pounds pressure.
6. Using block of hard wood (1" x 10"), drill two 1" holes so that block will fit over two studs in upper retainer.
7. Install bellows assembly in arbor press

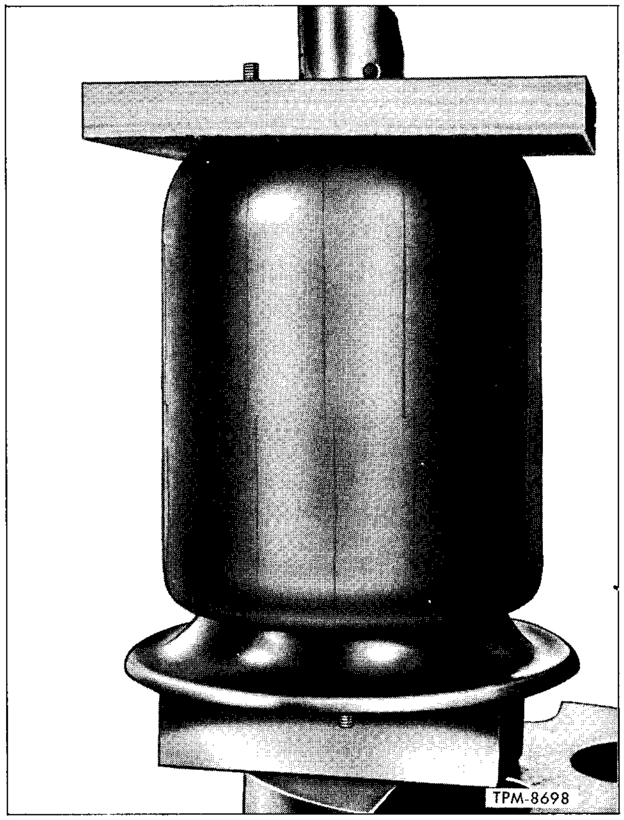


Figure 22—Bellows Loop Rolled over Piston

(fig. 21) with two studs in lower retainer astride a block so that assembly will rest against retainer and piston.

8. Install locally made block over top of bellows assembly with upper retainer studs through holes in block (fig. 21).
9. Operate arbor press so as to compress air and cause lower end of bellows to fold over piston. Continue to press until a dimension of approximately 12" overall height is obtained (fig. 22).

WARNING: Before releasing arbor press be sure that air is released from bellows by opening air valve.

10. Remove assembly from arbor press, then remove wood block and air supply valve.

INSTALLATION

1. Place mounting plate over studs in upper retainer. Edges of plate of front axle should extend downward. Install large nut and lock washer on large stud, and small nut on small stud. Tighten nuts to torque listed in "Specifications" at end of this section.
2. Place bellows assembly in position between suspension support and beam.

Front Bellows. The larger of two studs at top of each bellows assembly should be away from front axle. Seat mounting plate solidly against

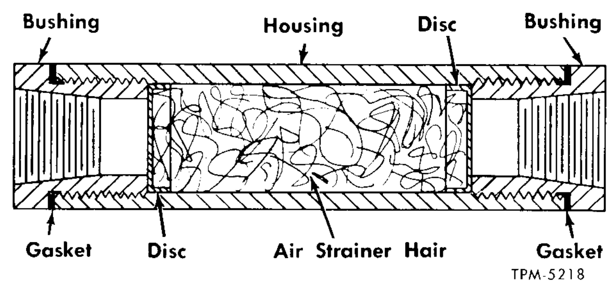


Figure 23—Air Filter

beam and attach with four bolts and lock nuts. Insert bolts from bellows side of plate. Install nut on stud at bottom of bellows. Tighten all nuts to torque listed in "Specifications."

Rear Bellows. The larger of two studs at top of each bellows assembly should be toward rear axle. Attach mounting plate with four bolts and four lock nuts. Install two lock nuts on studs at bottom of bellows. Tighten all nuts to torque listed in "Specifications" at end of this section.

3. Connect height control valve links, if disconnected. Make sure lever adjustment has not been changed.

4. Build up air pressure to normal operating pressure. Remove blocks from under coach.

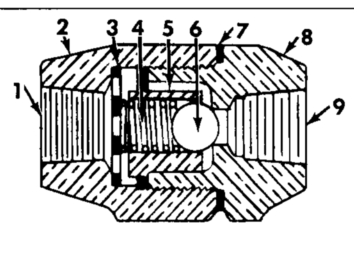
5. Check for air leaks at upper and lower mountings of bellows by coating with solution of soap and water. Any leaks showing up as bubbles must be stopped.

AIR FILTER

Air filter (fig. 23) is connected in air line at pressure regulator valve. Filter should be removed, disassembled, and cleaned yearly. Replace gaskets if necessary. Soak filter material in cleaning solvent. Dry the material and assemble filter. Tighten bushings firmly.

CHECK VALVE

Check valve (fig. 24) is spring-loaded ball type, permitting compressed air to flow in one direction only. Valve is located in air line between pressure regulating valve and suspension air tank. Check valves should be removed, disassembled, and cleaned at regular intervals. Check valve ball should be replaced if any wear or roughness is evident. Use a new gasket between valve cap and body when assembling valve. When installing valve, make sure that arrow stamped on valve cap points toward tank.



1 Air Outlet
2 Body
3 Spring Seat
4 Spring
5 Ball Guide
6 Ball
7 Gasket
8 Cap Nut
9 Air Inlet TP-9369

Figure 24—Air Tank Check Valve

PRESSURE REGULATING VALVE

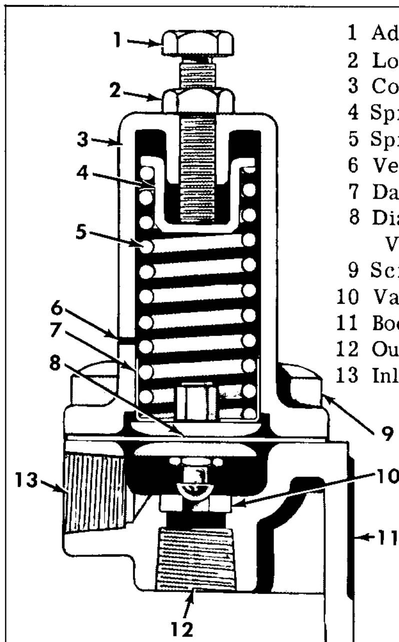
Pressure regulating valve (fig. 25) is mounted on coach body near suspension air tank. This valve serves two purposes. One purpose is to prevent entry of compressed air into air suspension system until pressure in air brake system reaches 65 psi. This makes possible a rapid build-up of air pressure for operation of air brakes. When brake system air pressure exceeds 65 psi, the pressure regulating valve opens and allows pressure to build up in suspension system. The second purpose of the valve is to prevent loss of brake system air pressure below 65 psi due to leakage in suspension system.

SERVICEABILITY TESTS

1. Operating Test

a. Exhaust compressed air from air system by opening drain cock at air tank. Close drain cock when tank is empty.

b. Connect a test air pressure gauge in brake



1 Adjusting Screw
2 Lock Nut
3 Cover
4 Spring Seat
5 Spring
6 Vent
7 Dampener
8 Diaphragm and Valve Assembly
9 Screw
10 Valve Seat
11 Body
12 Outlet Port
13 Inlet Port

Figure 25—Pressure Regulating Valve

system, preferably in line leading from air tank to pressure regulating valve.

c. Disconnect air line at bottom of pressure regulating valve.

d. Build up air pressure in system and note pressure on test gauge at instant valve opens and discharge air through open line.

e. Adjust valve if pressure varies 5 psi from the original setting (65 psi).

2. Leakage Test

With air line still disconnected at bottom of valve, build up air pressure to a point just below valve setting (65 psi). Coat opening with soap suds to check for leakage. Also apply soap suds to vent opening in valve cover.

No leakage is permissible at vent opening in valve cover. Leakage at this point indicates a ruptured diaphragm. Replace ruptured diaphragm with new part.

Leakage amounting to a 3-inch bubble in 3 seconds at outlet port is permissible. Excessive leakage is an indication of a dirty or worn valve or valve seat.

ADJUSTING PRESSURE SETTING (Fig. 25)

The adjusting screw (1) controls the pressure at which the valve is unseated. Setting may be increased or decreased by turning screw.

1. Back off lock nut (2). Turn screw clockwise to increase pressure, or counterclockwise to decrease pressure.

2. Tighten lock nut (2) when correct adjustment is obtained.

DISASSEMBLY

Remove four screws (9) attaching cover (3) to body (11) and remove cover. Remove spring seat (4) and dampener (7) from cover. Lift diaphragm and valve assembly (8) off body.

INSPECTION

Clean all parts thoroughly, using a suitable cleaning solvent. Examine diaphragm for cracks or wear. If either the valve or the diaphragm is worn or damaged, a new valve and diaphragm assembly (8) must be installed. Inspect valve seat (10) in body. If seat is pitted, scratched, or chipped, it should be replaced.

ASSEMBLY (Fig. 25)

Place diaphragm and valve assembly (8) on body, with valve seated in valve seat in body. Install spring seat (4), spring (5) and dampener (7) in cover (3) and position cover on body. Install four screws (9) through cover and diaphragm into body, and tighten firmly. Connect air pressure source to valve inlet and adjust set pressure.

HEIGHT CONTROL VALVE

DESCRIPTION

Height control valves operate automatically. Valves control the flow of compressed air into or out of bellows. Body of each height control valve contains intake valve, exhaust valve, and delay piston. Overtravel control body contains a spring-loaded nylon piston. Piston protects valve parts when overtravel lever is moved beyond normal operating range, and also provides a delay in the action of the valve so air is not used during momentary bumps, but only on load changes.

Three height control valves are used in coach air suspension system; one at front axle and two at rear axle. The valve at center of front axle has two air supply outlets, one for left-hand set and one for right-hand set of bellows. Each rear valve has a single outlet to supply air to bellows on that side (see fig. 5).

Except for valve body and overtravel shaft, parts in all three valves are similar. Front valve also contains a ball check valve in each inlet port and in each outlet port to prevent passage of air pressure from one side of the vehicle to the other. Each check valve consists of a small nylon ball.

HEIGHT CONTROL VALVE OPERATION

Figure 26 shows cross-section of a front valve assembly in the three phases of operation. Operation of a rear valve would be identical. Valve operation is illustrated as coach is unloaded, at normal ride height, and as coach is loaded. Each valve adjusts independently for the following conditions:

LOADING (Fig. 26)

When coach is loaded, coach body settles. Since valve is linked to suspension, and valve is bolted to body, valve moves downward with body as body is loaded. As overtravel lever and control shaft turns, inlet valve lever moves over against pin of valve core. As pin is pushed in, air pressure flows through height control valve into bellows. Increased air pressure expands bellows and raises body.

Inlet valve is "protected" by check valve (18, figs. 34 and 35) in inlet adapter. Light spring in core freely admits tank air, but return flow of air is blocked.

NEUTRAL POSITION (Fig. 26)

As increased air pressure expands bellows and lifts body, the height control valve moves up-

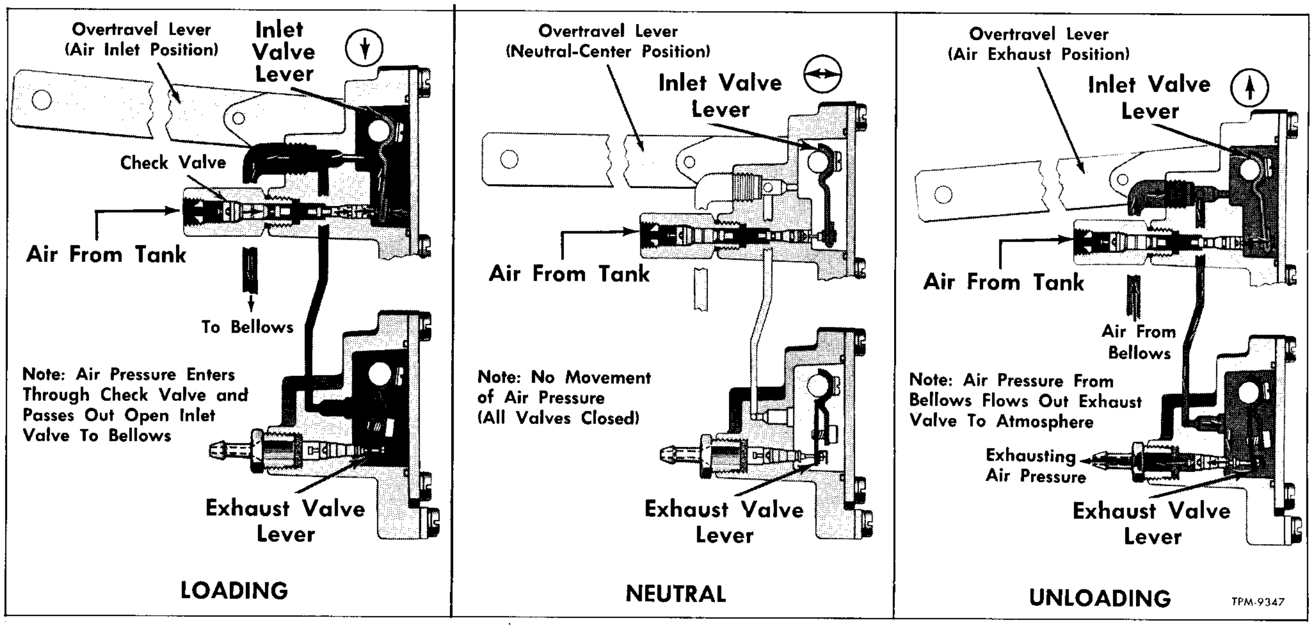


Figure 26—Operation of Height Control Valve (Front Shown)

ward with body. As body is returning to normal ride height, overtravel arm and shaft return to a neutral position. Inlet valve lever also moves away from inlet valve core and inlet valve closes. This stops the flow of air into the bellows. The exhaust valve remains closed. Since the exhaust valve is closed, and the check valve in the inlet adapter prevents compressed air from returning to tank, air is trapped in bellows and in valve. No further valve action or air pressure change takes place until load is increased or decreased, moving overtravel lever out of neutral position for one second or more to actuate intake valve or exhaust valve.

UNLOADING (Fig. 26)

When part of load is removed, air pressure in bellows lifts body. Overtravel lever, linked to suspension in rear and to axle in front, is pulled downward from neutral position. This applies a force on the delay piston which moves it slowly. The exhaust valve lever moves with the delay piston. The outer end of exhaust valve lever fits around stem of exhaust valve core. As soon as lever moves beyond free-travel range, lever pulls on stem and opens exhaust valve. Inlet valve remains closed. Compressed air from bellows then flows through the open exhaust valve and out exhaust fitting to atmosphere. As the compressed air is exhausted from bellows, the body lowers until overtravel lever and shaft are again in normal (neutral) position.

OVERTRAVEL LEVER FREE TRAVEL

With vehicle in motion and body at normal ride height, control valve overtravel lever and shaft are in neutral position as shown in figure 26. Small irregularities in road cause slight up and down movement of overtravel lever. Clearances are provided between operating levers and cores of inlet and exhaust valves to permit 3/16" up or down movement of overtravel lever from neutral position without causing valve action. This compensates for small road bumps. The bumps are absorbed by tires and bellows without causing movement of compressed air either into or out of suspension system.

HYDRAULIC DELAYING ACTION

Operation of a delay piston (5, figs. 34 and 35) in height control valve prevents change of bellows air pressure as result of momentary road shocks, conserves air pressure, and adds life to valve. The nylon piston moves inside cylinder containing a silicone type fluid. A flapper valve on either end of piston allows displacement of fluid or acts as a check valve, depending on direction piston moves. Delay piston is moved by piston pin (11, figs. 34 and 35) that is threaded into overtravel shaft. A one to six second delay results from the closing of one valve to the cracking of other valve. Intake and exhaust valves close from full open position within one second.

Overtravel piston (26, figs. 34 and 35) is held against flat side of overtravel shaft by two springs inside piston. Piston keeps overtravel shaft in proper position relative to overtravel lever. Piston also allows overtravel lever to rotate through a complete circle, if necessary, without damaging parts inside valve.

TROUBLESHOOTING HEIGHT CONTROL VALVE

MALFUNCTION	POSSIBLE CAUSE	CORRECTIVE MEASURE
1. Bellows deflate overnight.	a. Defective check valve assembly.	a. Replace check valve assembly.
	b. Defective exhaust valve assembly.	b. Replace exhaust valve assembly.
	c. Leak in air line and/or bellows.	c. Replace air line or bellows.
	d. Defective valve cover rubber O-rings or gasket.	d. Replace valve cover O-rings or gasket.
2. Bellows raise to full height and fail to exhaust air pressure.	a. A clogged exhaust screen (15, fig. 34) in height control valve assembly.	a. Remove, then clean screen.
	b. A combination clogged exhaust screen and a defective air inlet valve assembly.	b. Clean exhaust screen and replace air inlet valve assembly
3. Intermittent hissing noise at height control valve during operation.	a. Loss of time delay action fluid in height control valve assembly.	a. Add fluid, then install new cover and delay piston plug gasket O-rings.
4. Erratic valve action.	a. Dirt or foreign matter in the air valve lever chamber.	a. Remove valve cover and blow out dirt. Install cover using new rubber O-rings.
	b. Defective valves.	b. Overhaul height control valve assembly.
5. Vehicle body fails to level out.	a. Improper height control valve overtravel lever adjustment.	a. Make proper adjustments as directed previously under "Ride Height Check and Adjustment."

HEIGHT CONTROL VALVE REMOVAL

Before disconnecting any height control valve air lines, securely support body by placing blocks under coach at jack pads. Exhaust air from air supply system by opening drain cock in suspension air tank. After the above precautions have been taken, remove height control valve as follows:

1. Disconnect height control valve overtravel lever from valve link. Pull lever downward to release compressed air from bellows.
2. Disconnect air supply line and bellows air line from height control valve. Tape ends of all lines closed.
3. Remove two bolts, lock washers, and nuts attaching height control valve to mounting bracket and remove valve assembly.

HEIGHT CONTROL VALVE INSTALLATION

Before installing height control valve assembly, see that air line fittings are clean and undamaged. Replace line connector rubber sleeves if deteriorated or damaged.

DO NOT USE SEALING COMPOUND ON THREADS. Sealer is unnecessary, and if used, may cause valve cores to stick.

IMPORTANT: Absolute cleanliness is essential when installing height control valves. Dirt and sealing compound must be kept out of valves. Even minute particles of foreign matter may become lodged in valve cores or flapper valves and may seriously affect operation of suspension system.

The difference in height control valves is ex-

plained previously in "Description." Install valves as follows:

1. Position height control valve at mounting bracket. Attach with two bolts, nuts, and lock washers and tighten to torque listed in "Specifications" at end of this section.

2. Connect air supply line to intake check valve adapter. Connect bellows air line (two at front valve) to outlet adapter. Tighten air line connector nuts firmly.

3. Connect height control valve overtravel lever to valve link. Build up air pressure in system and test for leaks. Check ride height dimensions. Make adjustments as directed following:

HEIGHT CONTROL VALVE AIR LEAKAGE CHECK

NOTE: Air leakage check can be made when valve is installed on vehicle only for bellows mountings and air line connection leaks. The following instructions explain procedure for making air leakage check when valve assembly is removed from vehicle.

1. Clean exterior of valve assembly.

2. Connect air pressure line to air inlet port (fig. 27), then open the air pressure (80-110) psi).

3. Submerge valve assembly in a container of water, then watch for air bubbles when the overtravel lever is in the center position. No air should escape from any point of valve assembly.

4. If bubbles appear from the bellows port, this is an indication that the air inlet valve assembly is defective and must be replaced.

5. Remove air pressure line from air inlet fitting and connect it to the bellows port (fig. 27). If bubbles appear at the air inlet check valve port, this is an indication that check valve unit is defective and must be replaced.

6. If bubbles appear at the exhaust port (fig. 27), it is an indication that the exhaust valve assembly is defective and must be replaced.

7. If bubbles appear around edge of valve cover plate, the cover plate rubber O-rings (or gasket) must be replaced.

8. If no leaks are detected, remove valve assembly from the water, then with air pressure still connected to the bellows port, actuate overtravel lever to expel any excessive amount of water which may have entered exhaust valve chamber. Remove air line and connect it to the air inlet port and repeat operation here to remove water from air inlet valve chamber.

HEIGHT CONTROL VALVE ADJUSTMENTS

To properly adjust the height control valve, it is ESSENTIAL that the following procedures be followed and in the sequence mentioned.

Three main adjustments are required:

1. Overtravel lever center position adjustment.

2. Air intake and exhaust valve lever gap adjustments.

3. Time delay check.

NOTE: The height control valve assembly must be removed from vehicle to make the above adjustments.

Instructions for checking the ride height dimension are explained previously under "Ride Height Check and Adjustment."

IMPORTANT: The Silicone fluid should be drained from valve assembly before making the first two adjustments mentioned above.

NOTE: The following tools should be used when making valve adjustments.

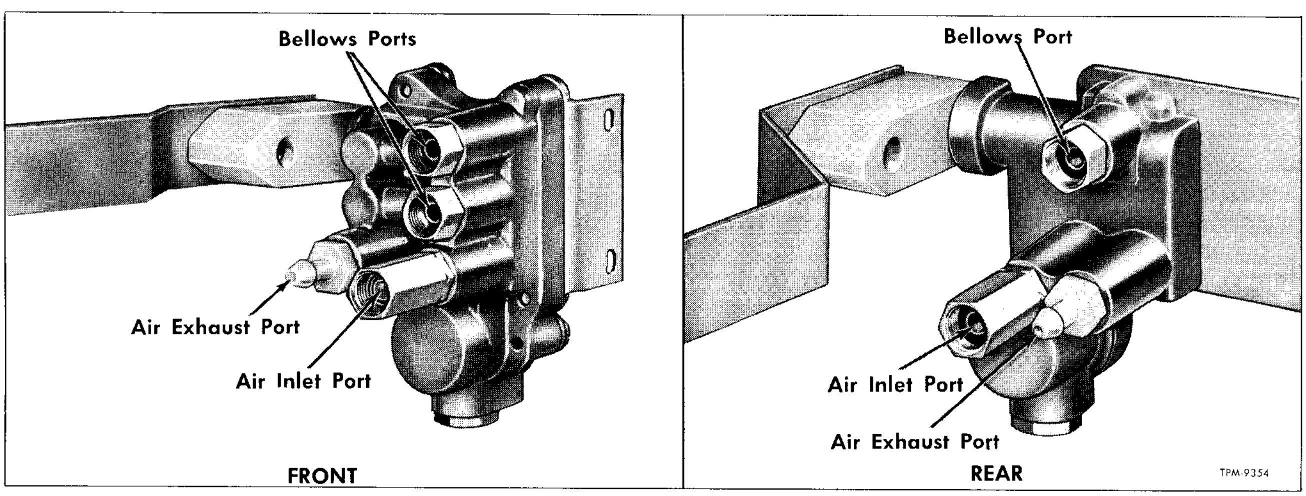


Figure 27—Identification of Valve Air Ports

REQUIRED TOOLS

Tool	Tool Number
Valve Core Replacer	J-6888
Overtravel Lever Piston Compressor	J-8424
Allen Wrenches (Sizes 3/32-inch and 1/8-inch)	Procure locally
Stop Watch	Procure locally
Dial Indicator Set (Having minimum range of 0.200 inch)	Procure locally
Air Line Fitting Assembly Consists of:	
(1) 2-Inch length of 1/4 H-9 hose	Procure locally
(1) Weatherhead pipe fitting	00904-104
(1) Weatherhead inverted fitting	00904-B04
Vacuum Line Fitting	Sun Tester #115-3
Depth Gauge and Straightedge	Procure locally
Conventional Type Eye Dropper	Procure locally

OVERTRAVEL LEVER CENTER POSITION ADJUSTMENT

1. Clean exterior of valve assembly.
2. Remove covers and rubber O-rings from valve assembly, then drain off the Silicone fluid.
3. Remove exhaust fitting (16, figs. 34 and 35) and exhaust screen (15, figs. 34 and 35) from valve.
4. Referring to figure 28, scribe a line 1-3/8 inch from plug end of overtravel lever control body.
5. Place valve assembly in vise as shown in figure 28.
6. If vacuum source is available, attach supply hose to valve exhaust port (fig. 27) using Sun Tester fitting #115-3 or equivalent. Do not apply vacuum at this time.
7. Attach air pressure supply hose to air inlet port (fig. 27). Do not apply pressure at this time.
8. Locate dial indicator in position as shown in figure 28. Move overtravel lever to full air exhaust position - TOP OF DELAY PISTON FLUSH WITH TOP OF BORE - without overtraveling (position "C," fig. 29). Relocate indicator push rod to just contact 1-3/8 inch mark on control body and reset indicator dial to zero (0) at this point (position "C," fig. 29).
9. Move overtravel lever to full air intake position without overtraveling (position "A," fig. 29) (delay piston at bottom of bore). Take indicator reading which may vary from 0.160" to 0.190".
10. Repeat steps 7 and 8 above to recheck this reading.
11. Divide the total travel dimension by two (example: 0.170" ÷ 2 = 0.085"), then move overtravel lever back this amount (0.085") to the center (position "B," fig. 29).

IMPORTANT: Without disturbing lever center position, reset indicator dial to zero (0), which actually is 0.100" on indicator of type registering 0.100" for each revolution of indicator needle, then proceed with valve lever gap adjustments following:

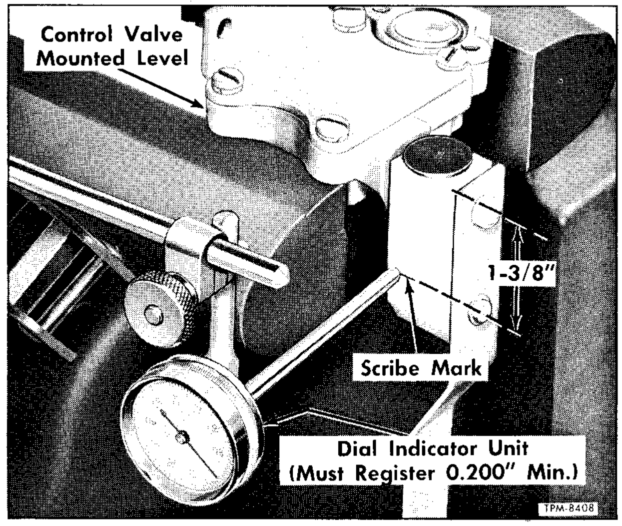


Figure 28—Dial Indicator Properly Installed

AIR INTAKE AND EXHAUST VALVE LEVER ADJUSTMENTS

IMPORTANT: Before making these adjustments the overtravel lever must be centered as explained previously.

Two methods of adjustment are available:

1. Using Both Air Pressure and Vacuum.

NOTE: If vacuum source is available, this method will take less time to perform adjustment. Vacuum source is used to make the exhaust valve lever gap check only.

2. Using Air Pressure Only.

NOTE: When this method is used, it will take longer to perform adjustments as the valve cover must be in place each time air pressure is applied and then removed to permit turning of exhaust valve lever adjustment screw.

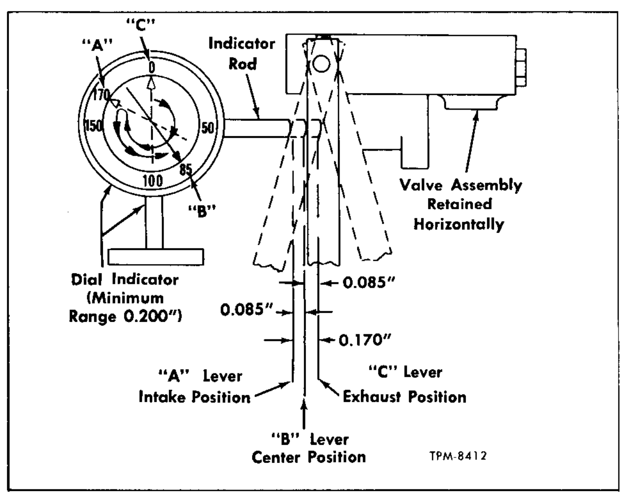


Figure 29—Locating Valve Overtravel Lever Center Position

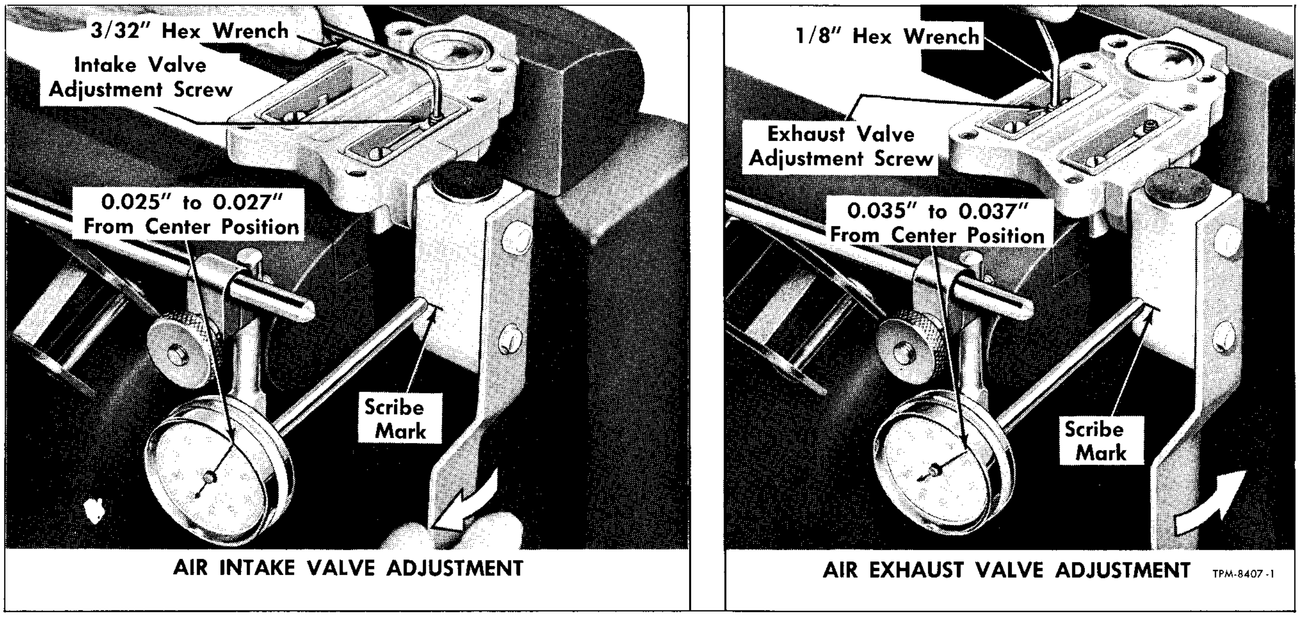


Figure 30—Method of Adjusting Air Valve Lever Gaps (Front Shown)

Instructions covering lever adjustments are identical for front and rear valves, except that portion which describes the actual setting of the levers. Front valve levers are set by screw adjustments but rear valve levers must be bent to proper setting. In rear valve, both exhaust and intake levers are part of one unit which contains "score" marks to permit easy bending. Mechanics may make a bending tool suitable to accomplish this operation with lever in the valve body, or lever may be removed and bent on the bench.

METHOD USING AIR PRESSURE AND VACUUM

1. If air supply and vacuum lines were not connected to valve assembly as directed previously when centering valve overtravel lever, connect lines.

2. Apply air pressure and regulate it to 80 to 110 psi. Apply vacuum and regulate it at approximately 15 inches.

3. Move overtravel lever fore and aft several times and then back to true center position.

4. Starting at true center position, slowly move lever to where air intake valve just begins to open. Listen for escaping air. Note reading on dial at this point. Reading should be 0.025" to 0.027" from lever center position. On front valves, using a 3/32" hex wrench, adjust screw on intake valve lever (left view, fig. 30) until correct setting is obtained. On rear valves, bend lever to correct setting.

5. Return overtravel lever to center position. Slowly move lever to exhaust side and at same time note the vacuum gauge reading. When vacuum just begins to fall off, the exhaust valve has opened. Valve should open when overtravel lever is moved 0.035" to 0.037" from center position. On front valves, using a 1/8-inch hex wrench, adjust exhaust valve lever adjustment screw as shown in right view, figure 30 as required. On rear valves, bend lever to correct setting.

NOTE: On front valves, if the adjustment screw is turned in too tight it must be backed off, and the two arms of exhaust lever spread apart as lever arms are not of the spring-back type. If this action was performed, repeat adjustment procedure above.

6. Recheck intake and exhaust valve lever gaps, then proceed with "Time Delay Check" explained later.

METHOD USING AIR PRESSURE ONLY

NOTE: This method may be performed when a vacuum source is not available.

1. Connect air supply hose (80 to 110 psi) to air inlet port (fig. 27).

2. To adjust air intake valve lever gap:

a. Move the overtravel lever slowly from true center position to point where intake valve just begins to open. Listen for escaping air. Note reading on dial at this point which should register 0.025" to 0.027".

b. On front valves using a 3/32" hex wrench adjust screw on intake valve lever (left view, fig. 30) until specified adjustment is obtained. On rear valves, bend lever to correct setting.

3. To adjust air exhaust valve lever gap:

a. Install valve cover on the valve using the two rubber O-rings and four attaching screws.

b. Being careful not to disturb indicator set-

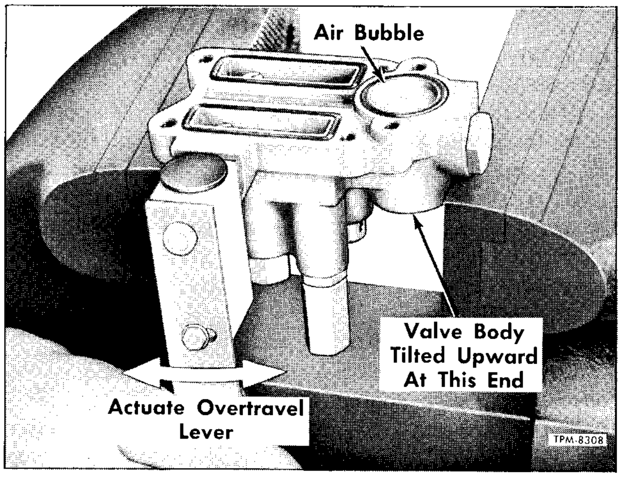


Figure 31—Venting Air From Silicone Fluid

ting, disconnect air supply from the air inlet port and connect it to the bellows port (fig. 27).

c. Move overtravel lever slowly to open exhaust port while observing the indicator dial. Air should start to escape from exhaust port when indicator registers 0.035" to 0.037". If adjustment is necessary, shut off air pressure supply and remove valve cover. On front valves, adjust screw setting; on rear valves, bend to correct setting, then install cover and recheck valve opening dimension.

NOTE: Turning adjustment screw clockwise reduces gap dimension and overtravel lever movement dimension. If the adjustment screw is turned in too tight, it must be backed off, and the two arms of exhaust lever spread apart. If this action was necessary repeat adjustment procedure above.

d. Recheck valve lever gaps, then proceed with "Time Delay Check" following:

TIME DELAY CHECK

PRELIMINARY PROCEDURES

After the valve lever gaps have been properly adjusted, the time delay check must be performed. A one to six seconds delay from the closing of one valve to the opening of the other is recommended. Also, valves should close from full-open position within one second.

1. Place new O-ring (12, figs. 34 and 35) over delay plug (13, figs. 34 and 35), then install plug into valve body. Tighten plug to 20-30 inch-pounds torque.

2. Pour 5.5 cc $\pm$ 0.25 cc of Silicone fluid (750 Centistokes viscosity at $25^{\circ}C$) into delay piston bore. With valve body tilted slightly as shown in figure 31 carefully operate overtravel lever fore and aft to vent air from fluid. When all air has been expelled from piston pin cavity, check fluid level using depth gauge as shown in figure 32.

IMPORTANT: With valve assembly level, take measurement from center of bore only. Add or remove fluid to bring fluid 1/8-inch from top of valve body on front valve, or 13/64 inch from top on rear valve. An eyedropper will serve for this purpose.

3. Place new delay piston cover O-ring in groove of valve body. Install cover with two attaching screws and tighten to 20-25 inch-pounds torque.

4. Place valve assembly vertically in holding vise (fig. 33).

5. Cycle arm up and down for approximately one minute.

AIR INLET TIME DELAY CHECK

1. Connect air pressure supply hose to valve air inlet port (fig. 27).

2. Move the overtravel lever upward (quickly) approximately two inches and simultaneously start

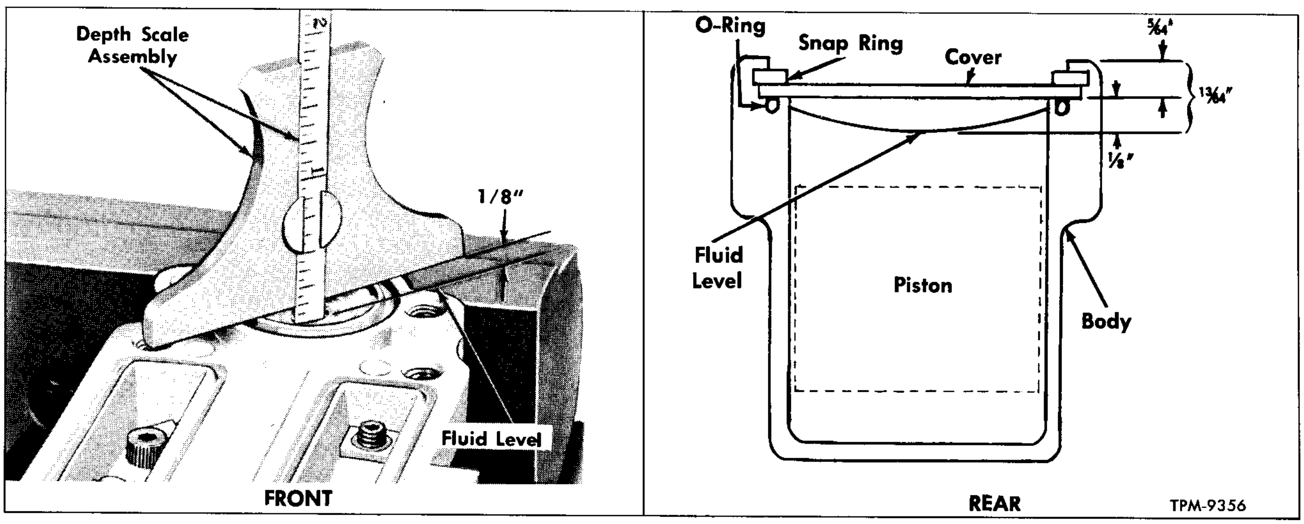


Figure 32—Measuring Fluid Level

counting the number of seconds before air starts to escape from bellows port. A delay of one to six seconds should exist. Repeat this check.

AIR EXHAUST TIME DELAY CHECK

To time the delay for exhaust, two methods can be used; one using vacuum source and one using air pressure.

1. Method Using Vacuum

a. Connect vacuum hose to air exhaust port (fig. 27). Adjust vacuum to 15 inches.

b. Move the overtravel lever downward (quickly) approximately two inches and simultaneously start counting the number of seconds before the vacuum gauge starts to drop off. A delay of one to six seconds should exist. Repeat this check.

2. Method Using Air Pressure

a. Install valve cover with rubber O-rings or gasket on valve assembly.

b. Connect air pressure supply hose to bellows port (fig. 27).

c. Move overtravel lever downward (quickly) approximately two inches and simultaneously start counting the seconds before air starts to escape from the exhaust port. A delay of one to six seconds should exist.

IMPORTANT: A time delay over six seconds could mean too large a valve lever gap adjustment and a time delay under one second would mean too small a valve lever gap adjustment. If the time delay is not within one to six seconds, first recheck the fluid level. If fluid level is satisfactory, the valve lever gap adjustment must be repeated, step by step.

NOTE: (Refer to figures 34 and 35.) After obtaining proper valve adjustments, install valve cover using new rubber O-rings or gasket (6). Install new screen (19), in bellows port, then using new O-ring (17), install outlet adapter (20) into bellows port. (NOTE: On front valves, two outlet adapters (20), screens (19), and nylon balls (40) are used.) If screen (15) was removed from exhaust port, install new screen and exhaust fitting (16).

NOTE: Place tape over ends of air line ports until such time valve assembly is installed on vehicle.

HEIGHT CONTROL VALVE OVERHAUL

Height control valves meter air into and out of the air suspension system. These valves are precision built and accurately adjusted. Parts must be carefully handled and assembled. Valves must also be accurately adjusted to insure proper operation after rebuild. Special tools mentioned previously should be used. Makeshift tools may break off chips that could lodge between valve and seats. Chips, dirt, and other foreign material could cause faulty valve operation.

NOTE: Repair parts kit is available which contains all parts usually requiring replacement in average overhaul. Parts in repair kit are indicated by asterisk (*) in figures 34 and 35.

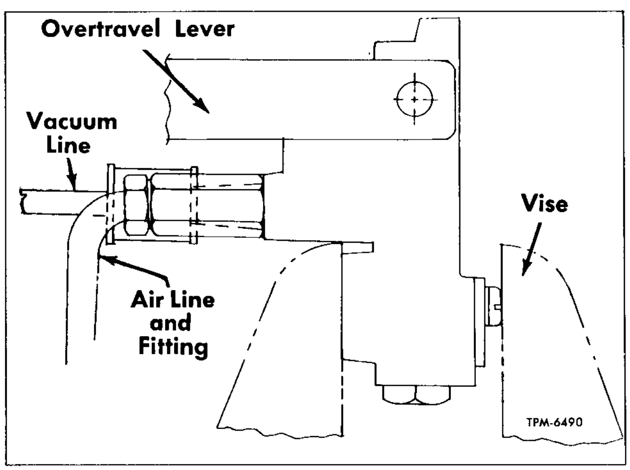


Figure 33—Valve Positioned For Time Delay Check

Key numbers shown in text refer to figures 34 (Front Valve) and 35 (Rear Valve). All parts common to both valves will have a common key number. Key numbers not common will be denoted by letter suffix "F" (Front) or "R" (Rear).

DISASSEMBLY

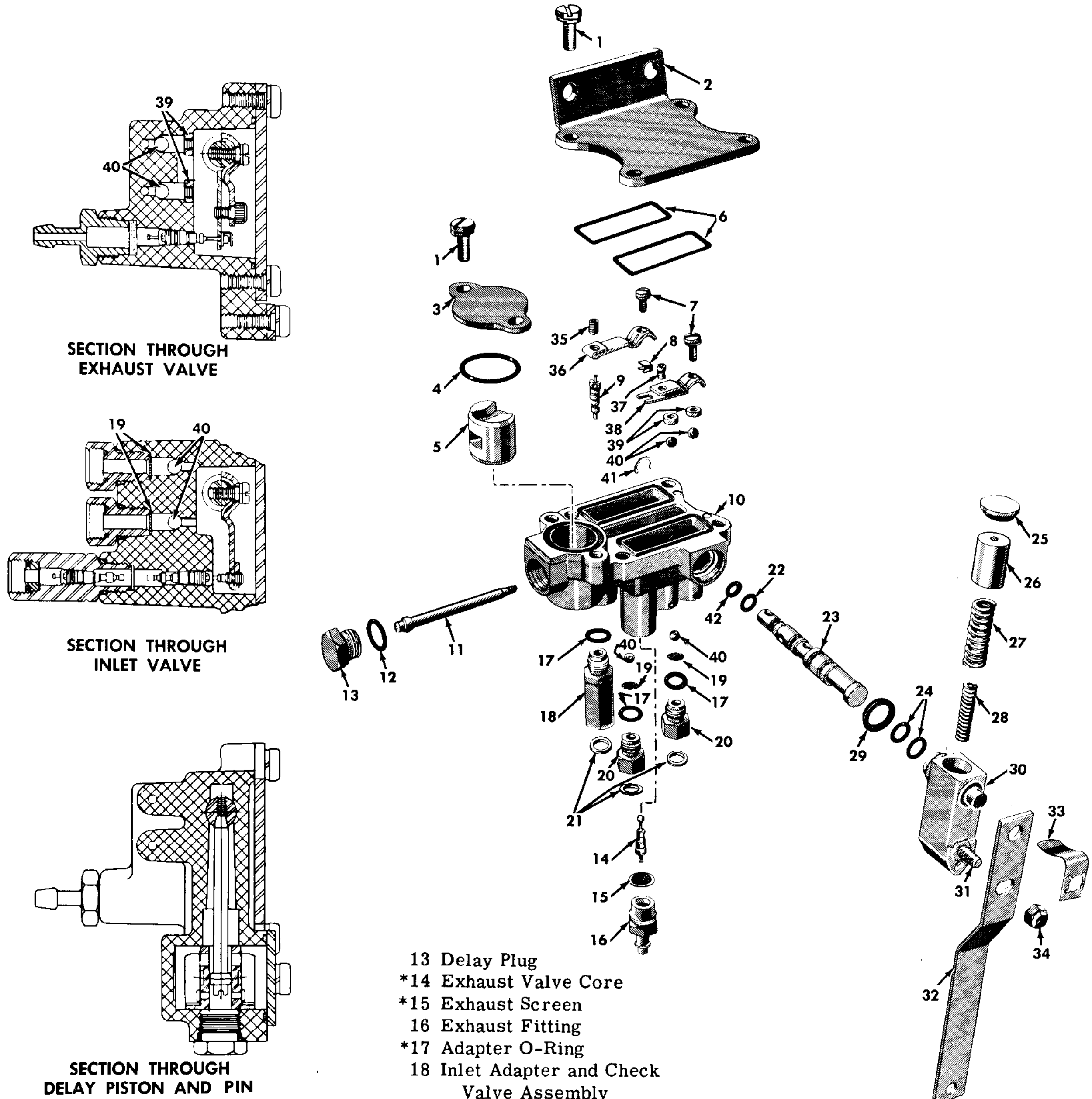
1. Remove inlet adapter and check valve assembly (18) from valve body (10). Remove outlet adapters (20) and nylon balls (40F). (Rear valves have only one outlet adapter (20) and no nylon balls are used.) Remove adapter O-rings (17). Remove air line fitting gasket (21) from adapters.

2. Remove four cover screws and lock washers (1) from cover and bracket (2). Remove cover and bracket and cover O-rings (6F) or gasket (6R).

3. Position valve with delay plug at top. Unscrew delay plug (13) from valve body. Drain silicone fluid from cavity. Remove plug O-ring (12). Unscrew piston pin (11) from control shaft.

4. On front valve remove two cover screws and lock washers (1) from cover (3). Remove cover and cover O-ring (4). Remove delay piston (5). Cover (3) on rear valve is retained by a snap ring (35R). Remove cover (3), O-ring and delay piston, accordingly.

5. Remove valve lever screw(s) and lock washer(s) (7) from valve lever(s). Remove exhaust valve lever (38F) and intake valve lever (36F) from valve body. Front valve has two separate levers while both levers (36R) are one unit in rear valve.



1 Cover Screw and Lock Washer
2 Cover and Bracket
3 Delay Cover
* 4 Delay Cover O-Ring
5 Delay Piston
* 6 Cover O-Ring
7 Valve Lever Screw
* 8 Valve Stem Lock Clip
* 9 Intake Valve Core
10 Valve Body
11 Piston Pin
*12 Plug O-Ring
13 Delay Plug
*14 Exhaust Valve Core
*15 Exhaust Screen
16 Exhaust Fitting
*17 Adapter O-Ring
18 Inlet Adapter and Check Valve Assembly
*19 Outlet Adapter Screen
20 Outlet Adapter
*21 Airline Fitting Gasket
*22 Shaft O-Ring (Medium)
23 Overtravel Control Shaft
*24 Shaft O-Ring (Large)
25 Overtravel Body Plug
26 Overtravel Piston
27 Overtravel Spring (Large)
28 Overtravel Spring (Small)
*29 Overtravel Control Body Seal
30 Overtravel Control Body
31 Overtravel Lever Stud
32 Overtravel Lever
*33 Plug Retainer
34 Lever Stud Nut
35 Intake Valve Lever Adjusting Screw
36 Intake Valve Lever
37 Exhaust Valve Lever Adjusting Screw
38 Exhaust Valve Lever
39 Nylon Ball Retainer
40 Nylon Ball
*41 Lever Retaining Ring
*42 Shaft O-Ring (Small)

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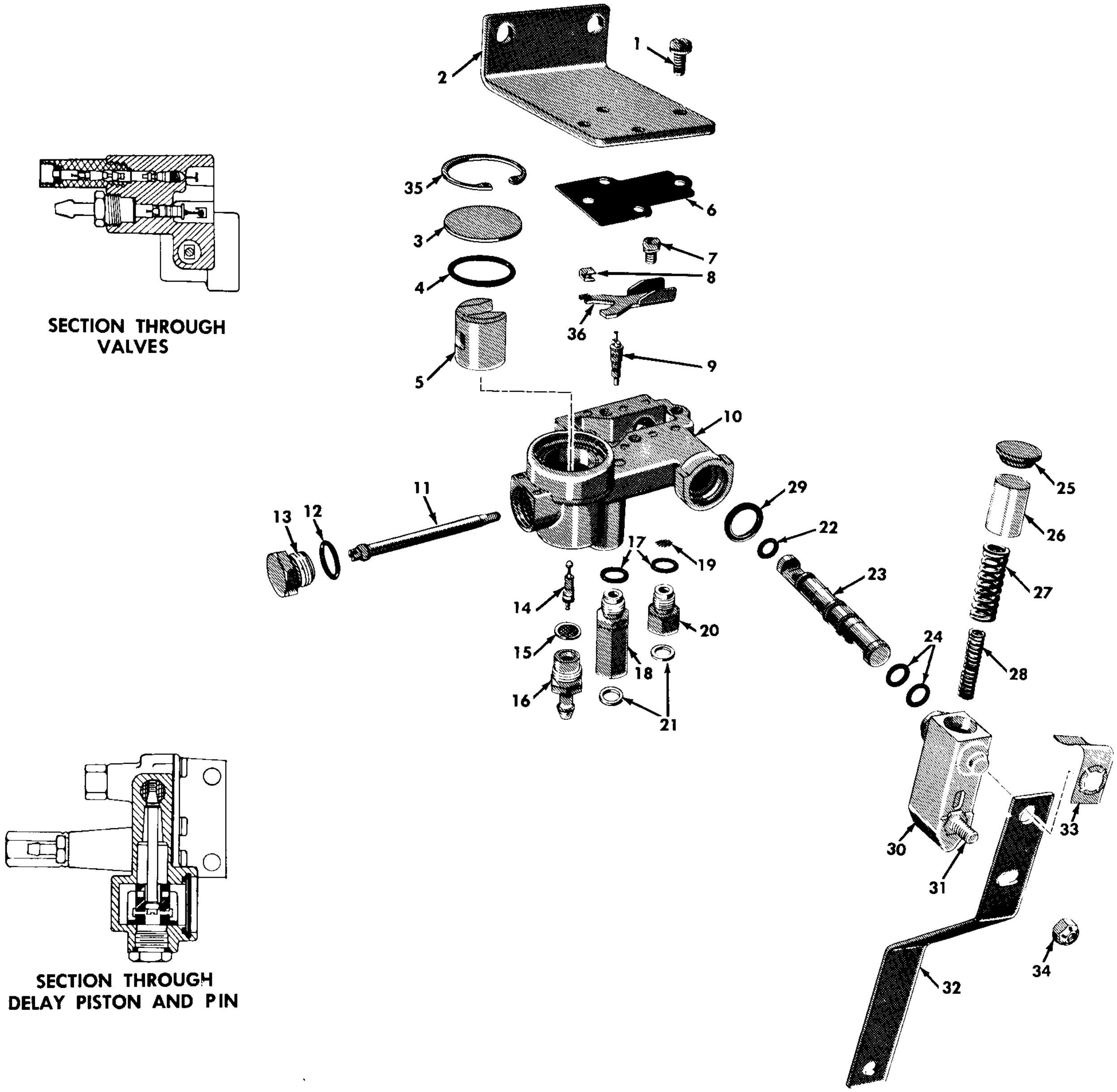
Figure 34—Height Control Valve and Components—Front



1 Cover Screw and Lock Washer
2 Cover and Bracket
3 Delay Cover
* 4 Delay Cover O-Ring
5 Delay Piston
6 Cover Gasket
7 Valve Lever Screw
* 8 Valve Stem Lock Clip
* 9 Intake Valve Core
10 Valve Body
11 Piston Pin
*12 Plug O-Ring
13 Delay Plug
*14 Exhaust Valve Core
*15 Exhaust Screen
16 Exhaust Fitting
*17 Adapter O-Ring
18 Inlet Adapter and Check Valve Assembly
*19 Outlet Adapter Screen
20 Outlet Adapter
*21 Airline Fitting Gasket
*22 Shaft O-Ring (Medium)
23 Overtravel Control Shaft
*24 Shaft O-Ring (Large)
25 Overtravel Body Plug
26 Overtravel Piston
27 Overtravel Spring (Large)
28 Overtravel Spring (Small)
*29 Overtravel Control Body Seal
30 Overtravel Control Body
31 Overtravel Lever Stud
32 Overtravel Lever
*33 Plug Retainer
34 Lever Stud Nut
35 Delay Cover Retainer
36 Intake and Exhaust Valve Lever

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Figure 35—Height Control Valve and Components—Rear

6. Remove valve stem lock clip (8) from stem of exhaust valve core. Spread locking arms and slide clip from around stem.

7. Remove retaining ring (41F - Front only) from overtravel control shaft. Pull overtravel assembly and shaft from valve body.

8. Remove intake valve core (9) with tool J-6888 as shown in figure 36. Remove inlet adapter screen.

9. Remove exhaust fitting (16) and screen (15), then remove exhaust valve core (14) with tool J-6888 as shown in figure 36.

10. On front valve only, remove two retainers (39F) and nylon balls (40F) from exhaust valve lever cavity in body. Threaded end of piston pin (11) can be used to lift ball retainers out of body.

11. Remove plug retainer (33) from overtravel control body (30). Retainer must be cut off. Use caution to avoid damage to nylon body. Remove overtravel body plug (25).

12. Place forked end of tool J-8424 around shaft in overtravel control body, then tighten clamp screw. See figure 37. CAUTION: TIGHTEN TOOL UNTIL OVERTRAVEL CONTROL SHAFT (23) CAN BE TURNED 90° TO ALLOW NOTCH IN SHAFT TO PASS FREE OF OVERTRAVEL PISTON (26). DO NOT APPLY MORE PRESSURE THAN IS REQUIRED. Remove overtravel control shaft (23) and overtravel control body seal (29) from body. Remove shaft O-rings (22, 24, and 42F). Back off vise jaw and take body and tool from vise. Remove tool, overtravel piston (26), overtravel lever large spring (27), and overtravel lever small spring (28) from body. Remove lever screw nut (34) from overtravel lever screw or stud. Remove lever (32) from body.

CLEANING AND INSPECTION

1. The following parts should be discarded and replaced with new parts at each overhaul: Plug retainer (33), overtravel control body seal (29), and O-rings (4, 6F, 12, 17, 22, 24, and 42F).

2. Thoroughly clean all metallic parts in a suitable cleaning solvent. Blow parts dry with compressed air.

3. Inspect all bearing and rubbing surfaces for scoring, fractures, or noticeable wear. Discard all damaged or worn parts and replace with new parts.

ASSEMBLY

CAUTION: HEIGHT CONTROL VALVE PARTS MUST BE KEPT FREE FROM DIRT AND MOISTURE.

1. Install intake valve core (9) and exhaust valve core (14) in body with tool J-6888 in manner shown in figure 36. Tighten to 2-1/2 to 3 inch-pounds torque.

2. On front valves only, place two nylon balls (40F) in passages at bottom of exhaust valve lever cavity in body. Install ball retainers (39F).

3. Lubricate overtravel body with multi-purpose grease. Assemble overtravel components as follows:

a. Install overtravel lever (32) on body. Place lever stud nut (34) on stud and tighten to 70-80 inch-pounds torque.

b. Place overtravel lever large spring (27), and overtravel lever small spring (28) inside piston (26). Insert piston in body (30).

c. On front valve, place four new O-rings (22, 24 and 42F) on overtravel control shaft (23) as shown (on rear valve there are only three O-rings). Lubricate shaft and O-rings with multi-purpose grease.

d. Position fork of tool (J-8424) so that shaft can be inserted in body. Carefully apply pressure with clamp screw (fig. 37). Compress springs only

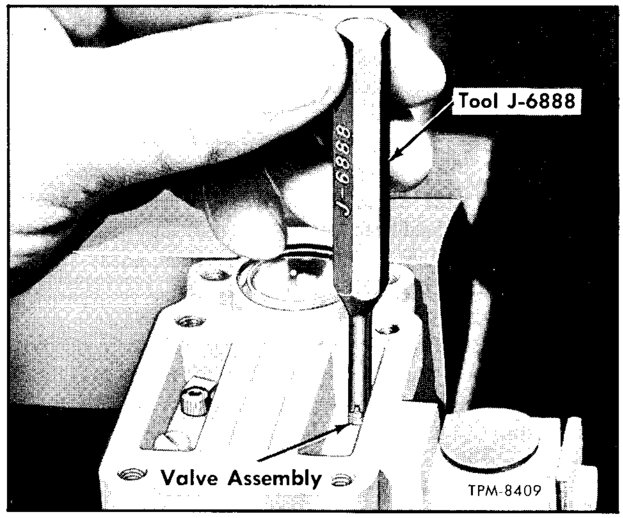


Figure 36—Replacing Valve Core Assemblies

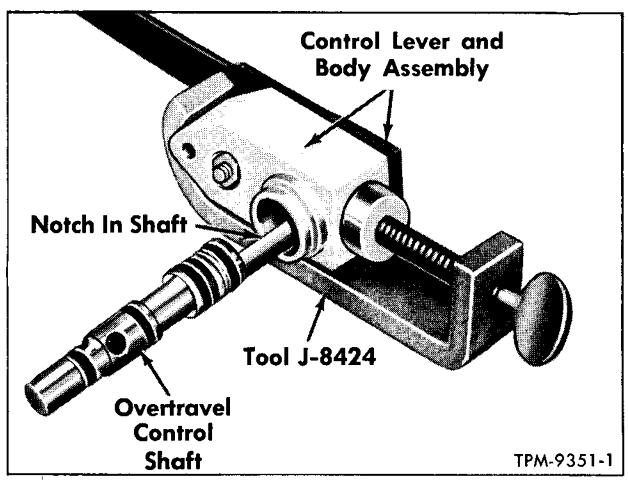


Figure 37—Replacing Overtravel Lever

enough to allow shaft to be inserted. Install overtravel control shaft (23). Rotate shaft so that flat is next to piston.

e. Insert overtravel body plug (25) in bore of body. Force new plug retainer (33) in position over nylon pivot and body plug.

f. Place new overtravel control body seal (29) on shoulder of body. Slide overtravel assembly into valve body (10). Insert carefully to avoid O-ring damage. On front valve secure shaft by installing retaining ring (41F).

4. Install delay assembly as follows:

a. Place delay piston (5) in valve body with open side of piston toward the overtravel shaft.

b. Align pin openings in piston and in shaft. Fit piston pin (11) in TAPERED SIDE of hole in shaft. Tighten pin to 8-10 inch-pounds torque.

5. Place intake valve lever (36F) and exhaust valve lever (38F) in position on overtravel shaft (combined in one piece - 36R - on rear valve). Place exhaust valve lever fork around stem of valve core. Fork should be high enough on stem so that stem will not be held open. Insert valve lever screws (7) and lock washers and tighten to 8-10 inch-pounds torque.

6. Spread ends of valve stem lock clip (8) slightly and place on exhaust valve stem around stem head. Use suitable tool to brace stem, and pinch ends of clip just enough to secure on stem. Clip must rotate freely on stem.

7. Using new O-ring (17), install air inlet adapter and check valve assembly (18) into valve body.

8. At this stage of assembly, make all of the valve assembly adjustments as explained previously under "Height Control Valve Adjustments."

SHOCK ABSORBERS

DESCRIPTION

Shock absorbers used at front and at rear axles are double-acting, telescoping type. The principal components of the shock absorber, illustrated in figure 38 are: Piston and valving assembly (8), piston rod (4), rod guide and seal assembly (2), cylinder tube (7), base valving assembly (9), reservoir tube (6), shield (5), and mounting eyes (1). The cylinder tube (7) is completely filled with special hydraulic fluid, with an additional amount in the reservoir tube.

Front and rear shock absorbers are identical in appearance and size, however, they are not interchangeable. Internal valving for front and rear units are different, and it is important that the correct shock absorber be used at front and rear. Part number is stamped on each unit, and reference should be made to "Specifications" at end of this section to make sure correct unit is being used.

SHOCK ABSORBER OPERATION

Starting with the shock absorber in closed position as illustrated in figure 38, the control of the opening or "rebound" stroke is as follows: As the piston assembly (8) travels upward, the fluid is compressed in the top portion (A) of the cylinder tube (7) and is forced through orifices in the piston and the rebound control valving located in the bottom of the piston. To replace fluid displaced by the piston rod (4) when in closed position, fluid is drawn from the reservoir section (C) in the reservoir tube (6) through the intake valve section of the base valve (9) into the lower portion (B) of the cylinder tube (7).

The spring and piston making up the rebound cut-off assembly (3) act as an additional cushion for the last inch of rebound stroke. When piston and valving assembly (8) reaches rebound cut-off assembly, the oil passage between piston and piston rod closes. All oil displaced during last inch of

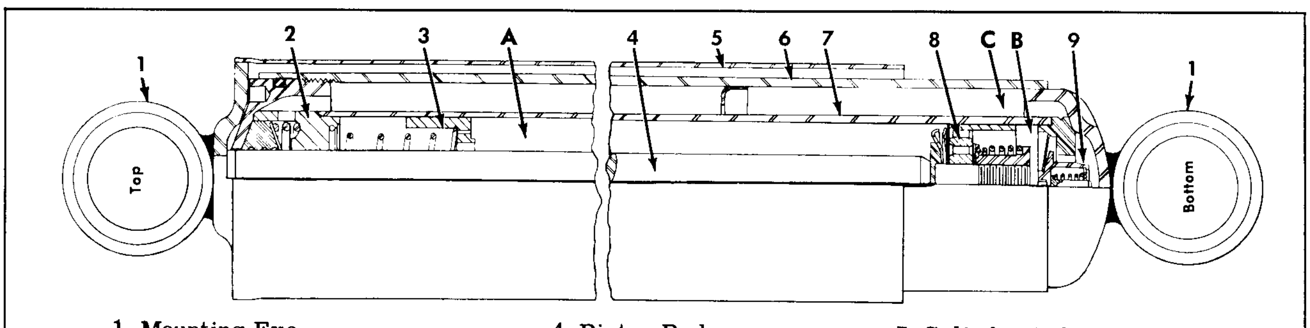


Figure 38—Sectional View of Shock Absorber

travel must flow through a small (0.073") hole in rebound cut-off piston. This restriction of oil flow results in greater dampening effect through last inch of "rebound" travel. At compression stroke, spring in rebound cut-off assembly returns piston to original position.

The closing or "compression" stroke of the shock absorber is controlled as follows: Fluid pressure for control of the compression stroke is developed entirely by the displacement of the piston rod (4) as it enters the fluid-filled cylinder tube (7). The piston (8) does not function, (as a piston) during this cycle since fluid is by-passed from section (B) to section (A) of the cylinder tube (7) through the check valve located in top of piston. The check valve opens on the compression stroke and closes on the rebound stroke.

The fluid displaced by the piston rod (4) entering the cylinder tube (7) is expelled through an orifice in the base valve (9) into the reservoir (C). However, as the velocity of movement increases, the pressure will build up faster than the orifice can bleed it out. When this pressure overcomes the force of the spring in the relief valve section of the base valve, the relief valve lifts from its seat, permitting greater flow and maintaining the internal pressure at the predetermined limit.

SHOCK ABSORBER SERVICE

Shock absorbers are of welded construction and cannot be repaired. Shock absorber not operating properly should be replaced with a new unit.

SHOCK ABSORBER REMOVAL

Remove nuts and washers from shock absorber upper and lower anchor pins. Pull shock absorber and rubber bushings off anchor pins.

SHOCK ABSORBER INSTALLATION

Refer to "Specifications" for model and valve code numbers to be sure correct unit is being installed. Make sure shock absorber mounting eyes and anchor pins are clean. Place one rubber bushing on each anchor pin, install shock absorber eyes over anchor pins, then install second rubber bushing, washer, and nut on each anchor pin. Tighten nuts to torque listed in "Specifications."

Refer to next page for "Specifications."

SPECIFICATIONS

AIR BELLOWS

Make (Optional)................The Goodyear Tire and Rubber Co.
Make (Optional)..................Firestone Industrial Products Co.

	FRONT	REAR
Nominal Working Diameter	8″	10″
Nominal Working Height	11½″	11½″

HEIGHT CONTROL VALVES

Make..Delco Products
Part No. (Stamped on Overtravel Lever)
- Front..5544440
- Right Rear.....................................5549703
- Left Rear......................................5549704

SHOCK ABSORBERS

Make..Delco Products
Type..................................Double-Acting, Telescoping

Identification	FRONT	REAR
Part Number	5552526**	5552527**
Model Number	480X	480X
Valve Code	6L10/j3	3N10/j3
Collapsed Length*	16⅞″	16⅞″
Extended Length*	26⅛″	26⅛″
Travel	9¼″	9¼″

*Length Measured from center to center of mounting eyes.

TORQUE SPECIFICATIONS

HEIGHT CONTROL VALVE

Valve Cores	2½-3 in.-lbs.
Intake and Exhaust Valve Lever Screws	8-10 in.-lbs.
Piston Pin	8-10 in.-lbs.
Exhaust Plug	20-30 in.-lbs.
Delay Plug	20-30 in.-lbs.
Cover Screw	15-20 in.-lbs.
Overtravel Lever Adjusting Nut	70-80 in.-lbs.

REAR AXLE SUSPENSION COMPONENTS

Bellows Support to Axle Bolt Nut	200-220 ft.-lbs.
Bellows to Bellows Support Stud Nut	8-10 ft.-lbs.
Bellows to Adapter Plate Stud Nut (Small)	8-10 ft.-lbs.
Bellows to Adapter Plate Stud Nut (Large)	15-20 ft.-lbs.
Lateral Radius Rod Cap Screw	90-100 ft.-lbs.
Lateral Radius Rod Anchor Bolt Nut	200-220 ft.-lbs.
Anchor Plate Radius Rod Bushing Bolt Nut	320-350 ft.-lbs.
Radius Rod Bolt Nut	490-520 ft.-lbs.
Leveling Valve to Bracket Bolt Nut	8-10 ft.-lbs.
Valve Link to Link Arm Stud Nut	8-10 ft.-lbs.
Axle Bumper Stud Nut	20-30 ft.-lbs.

FRONT AXLE SUSPENSION COMPONENTS

Radius Rod Bracket to Bellows Support Stud Nut	190-210 ft.-lbs.
Mounting Plate to Bellows Beam Angle Bolt Nut	15-20 ft.-lbs.
Bellows to Bellows Beam Stud Nut (Large)	15-20 ft.-lbs.
Bellows to Bellows Beam Stud Nut (Small)	8-10 ft.-lbs.
Bellows to Bellows Support Stud Nut	8-10 ft.-lbs.
Support Bracket U-Bolt Nut	90-110 ft.-lbs.
Anchor Angle to Upper Radius Rod Bracket Bolt Nut	80-90 ft.-lbs.
Radius Rod Bolt Nut	490-520 ft.-lbs.
Lateral Radius Rod Cap Screw	90-100 ft.-lbs.
Axle Bumper Stud Nut	20-30 ft.-lbs.
Leveling Valve Bracket to Crossmember Angle Bolt Nut	15-20 ft.-lbs.
Leveling Valve to Bracket Bolt Nut	8-10 ft.-lbs.
Valve Link to Link Arm Stud Nut	8-10 ft.-lbs.
Bellows Support to Axle Bolt Nut	300-350 ft.-lbs.

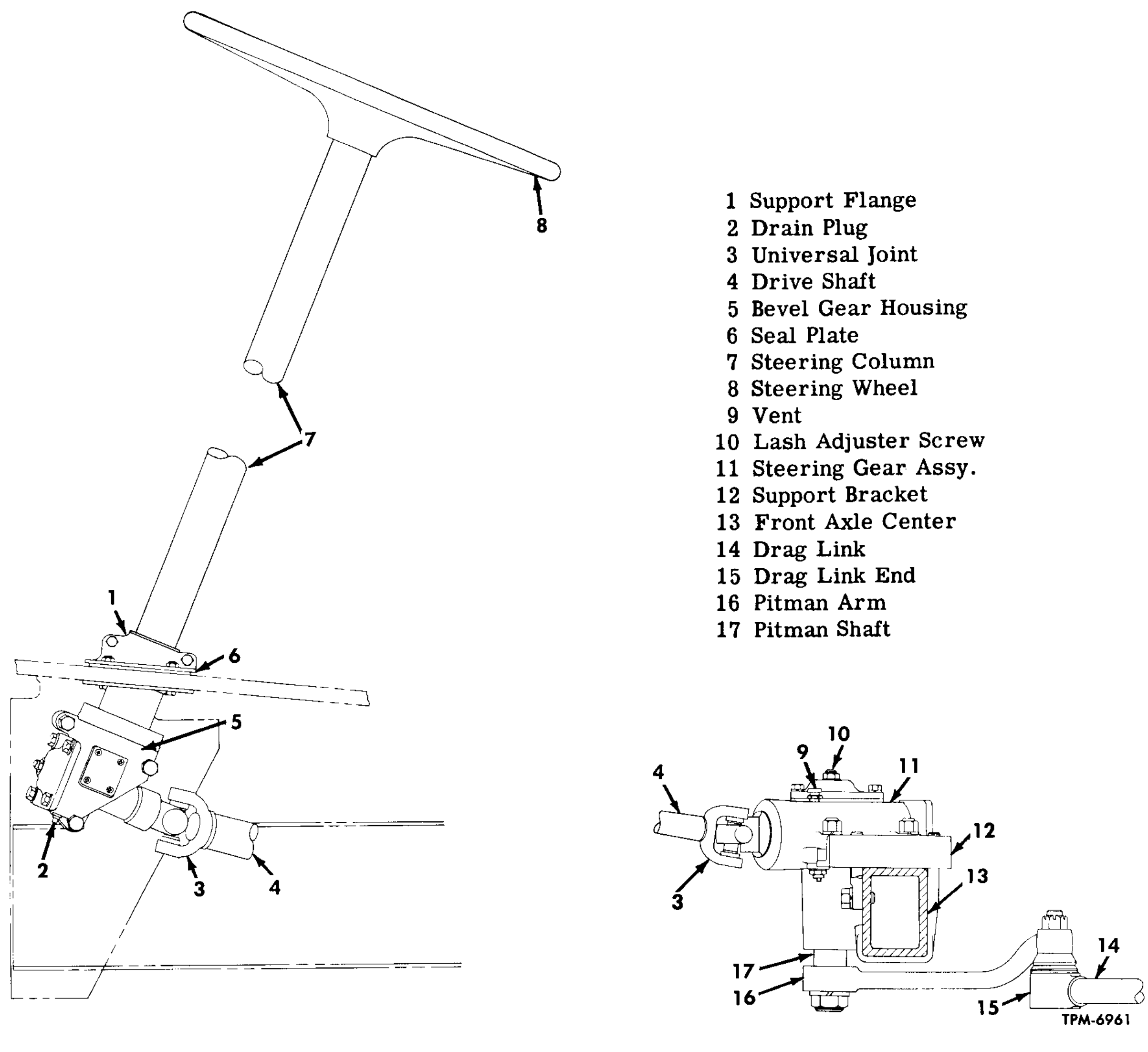
STABILIZER BAR (FRONT AND REAR)

Stabilizer Bar Support Bracket Bolt Nut	20-30 ft.-lbs.
Stabilizer Bar Bushing Retainer Clamp Bolt Nut	20-30 ft.-lbs.
Stabilizer Bar Link Stud Nut	175 ft.-lbs. min.

**On late models, Part Number 3178106 will be used both front and rear and may be used (in pairs only) to replace either early type. Valve code is 3P10-10/j3. All other specifications are identical.

Steering System

This group of the manual includes service information on both mechanical and power steering on coaches covered by this manual. The power units used in conjunction with the conventional steering gear units are covered under "Power Steering" later in this group. All other information applies to both systems with exceptions noted in text. This group is divided into two separate sections as shown in the following Index:



1 Support Flange
2 Drain Plug
3 Universal Joint
4 Drive Shaft
5 Bevel Gear Housing
6 Seal Plate
7 Steering Column
8 Steering Wheel
9 Vent
10 Lash Adjuster Screw
11 Steering Gear Assy.
12 Support Bracket
13 Front Axle Center
14 Drag Link
15 Drag Link End
16 Pitman Arm
17 Pitman Shaft

Figure 1—Steering System Installation (Typical)

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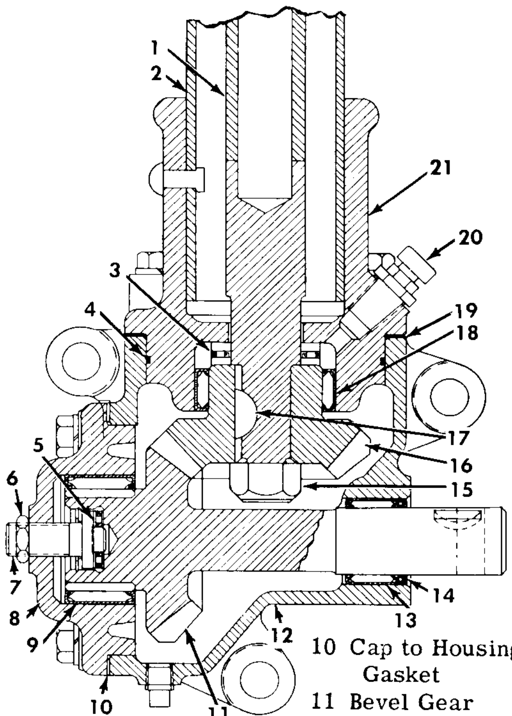
Mechanical Steering

GENERAL

The steering system is comprised of steering column and bevel gear assembly, drive shaft, steering gear assembly, drag link, and allied parts of front axle (fig. 1).

The steering gear is a conventional recirculating ball bearing and sector nut type, mounted on the front axle center and connected to the steering column bevel gear unit by a drive shaft as shown in figure 1.

Related front end assemblies which may affect steering operations: Air Suspension, Brakes, Wheel Bearings, Front Axle, and Front End Alignment are covered in their respective groups in this manual.



1 Steering Shaft
2 Steering Column Tube
3 Steering Shaft Lower Bearing
4 Tube to Housing O-ring Seal
5 Bevel Gear Bearing
6 Lock Nut
7 Bevel Gear Screw
8 Housing Cap Assy.
9 Housing Cap Bearing
10 Cap to Housing Gasket
11 Bevel Gear
12 Bevel Gear Housing
13 Housing Bearing
14 Retainer
15 Pinion Gear to Shaft Nut
16 Steering Shaft Pinion Gear
17 Woodruff Key
18 Housing Upper Cover Bearing
19 Shim Pack
20 Housing Vent Assy.
21 Housing Upper Cover

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Figure 2—Steering Column and Bevel Gear

Specifications and other pertinent steering system information is given in "Specifications" at the end of each section.

CONSTRUCTION AND OPERATION

MOUNTING (Fig. 1)

Steering system installation is illustrated in figure 1. Steering column and bevel gear housing assembly is bolted to a bracket on left-hand frame longitudinal member, with steering column extending upward through floor. Steering column support flange and seal plate are attached to floor with four bolts.

Steering gear assembly is mounted on support brackets on front axle center. Position of gear on axle center is maintained by two bolts through the gear housing flange into the front of the axle center. Support brackets are attached to axle center with U-bolts. Steering gear is mounted with Pitman shaft pointing down. Pitman arm extends rearward under axle and is connected to the drag link. Drag link is connected to steering arm at left front wheel.

STEERING COLUMN AND BEVEL GEAR (Refer to Figure 2)

Bevel gear housing upper cover is pressed onto and riveted to steering column tube. Steering shaft pinion gear is pressed onto steering shaft and secured with Woodruff key and lock nut. The upper pinion gear is mounted in roller needle bearings in bevel gear housing upper cover. Upper pinion gear is adjustable toward lower bevel gear by means of shims used between gear housing upper cover and bevel gear housing.

Lower bevel gear is mounted in needle bearings in bevel gear housing and housing cap assembly and is adjustable toward steering shaft pinion gear by means of a thrust screw. Steering drive shaft flange is keyed to lower bevel gear and is secured by bolt, nut, and lock washer.

Upper end of steering shaft is supported by a ball bearing assembly which is pressed into steering column tube. Horn cable guard is attached to steering column tube with three screws. Steering wheel is keyed to upper end of steering shaft and secured with a nut. Horn contact, spring, button, and components are mounted on upper end of shaft and in center of steering wheel as shown in figure 3.

STEERING DRIVE SHAFT (Fig. 8)

Steering drive shaft, connecting lower bevel

gear to steering gear worm, is a tubular type drive shaft equipped with needle bearing type universal joints. Splined slip joint at steering gear end of drive shaft compensates for changing length due to movement of front axle in relation to coach body. Universal joint flanges are connected to flanges on lower bevel gear and steering gear worm shaft.

WORM SHAFT AND NUT (Refer to Figure 9)

The steering worm, which is welded to worm shaft, is mounted in steering gear housing between two tapered roller bearings. Bearings are adjusted to control worm end play by means of shims used between the housing upper cover and gear housing. Helical cut groove in worm is precision finished to serve as a race for balls between worm and worm nut. Bore of worm nut is threaded with a precision finished helical groove corresponding to groove in worm. Worm nut balls are inserted in helical grooves between worm and worm nut in two separate circuits. Two tubular ball guides fit into worm nut and are clamped in place. These guides deflect worm nut balls from end of circuit in worm nut, returning them to helical path at start of circuit. Worm nut balls are the only contact between worm and nut. When worm is turned, worm ball nut moves along worm and at the same time, worm nut balls roll freely between worm and nut, circulating within their separate circuits. This arrangement provides a rolling instead of a sliding contact between parts.

Rack teeth on one side of worm nut mesh with teeth on Pitman shaft; thus, endwise movement of worm nut causes Pitman shaft to rotate.

Shaft yoke is keyed to drive shaft end of worm and secured with a pinch bolt. Oil seal is pressed into gear housing. Seal wipes on shaft yoke hub.

PITMAN SHAFT (Fig. 9)

Teeth on Pitman shaft are not ordinary spur gear type, but are specially designed to provide true rack and sector gear action when worm nut is positioned at a slight angle. This construction permits simple lash adjustment by shifting the Pitman shaft along its axis by means of the lash adjuster screw. With Pitman shaft adjusted to eliminate all lash at straight-ahead position, sector teeth design provides a slight lash when wheels are turned far to right or left. This design permits adjustment for wear of sector teeth in straight-ahead position without causing binding of teeth in less used portion of sector (extreme left or right position).

Pitman shaft is mounted on three needle type roller bearing assemblies, two in gear housing and one in housing side cover. An oil seal is pressed into housing at Pitman arm end of Pitman shaft.

MAINTENANCE

The following light maintenance operations include inspection and adjustment items which may be accomplished without removing the steering gear from the vehicle.

1. At regular intervals, check and if necessary, tighten all steering gear mounting bolts, bevel gear housing mounting bolts, drive shaft yoke bolts, Pitman arm retaining nut, drag link to Pitman arm and steering arm retaining nuts, tie rod to steering arm retaining nuts, and all assembly bolts on steering gear and bevel gear housing.
2. Check steering gear adjustments and adjust if necessary. Refer to "Steering Gear Adjustments" later in this section.
3. Check front end alignment: Refer to "FRONT END ALIGNMENT" (SEC. 1) of this manual.
4. Lubricate steering gear and allied units at regular intervals, as indicated in LUBRICATION (SEC. 13) of this manual.

STEERING GEAR ADJUSTMENTS

Before an attempt is made to remedy steering difficulties by adjusting the steering gear, other factors which might cause hard or otherwise unsatisfactory steering should be checked. Particular attention should be given to tire inflation, lubrication, wheel bearings, brakes, air suspension alignment, front end alignment, and worn, bent, or broken front axle parts.

It is important that the steering gear be properly adjusted to assure satisfactory steering and to prevent excessive wear of parts. Adjustments are provided for worm bearing end play and Pitman shaft lash.

Always check worm bearing adjustment, and adjust if necessary, prior to making Pitman shaft lash adjustment.

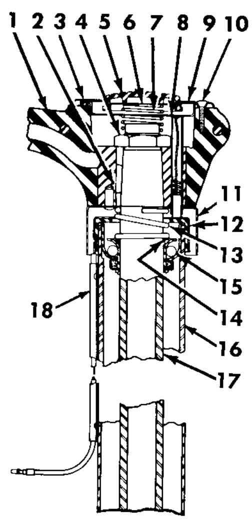
Before making adjustments, the following preliminary operations are necessary:

1. Disconnect steering drag link from Pitman arm by removing nut from end stud and driving end stud out of arm. Drag link should remain disconnected until all adjustments are completed.
2. Disconnect drive shaft universal joint yoke from yoke on worm shaft by removing U-bolts and lock nuts. Obtain a bar which can be bolted to worm yoke, with a hole in bar 10 inches from center of worm.

WORM BEARING CHECK AND ADJUSTMENT

Key numbers in text refer to figure 9.

1. Loosen lash adjuster lock nut (2) and turn lash adjuster screw (1) counterclockwise a few turns. This relieves load imposed on worm bearings by close meshing of teeth on worm nut and Pitman shaft sector.



1 Steering Wheel
2 Woodruff Key
3 Horn Button Insulator
4 Steering Wheel Retaining Nut
5 Horn Button
6 Horn Button Terminal Plate
7 Horn Button Spring
8 Connector, Sleeve, and Brush Assembly
9 Horn Button Retainer
10 Retainer Screw
11 Cancelling Plate
12 Contact and Cable Assembly
13 Steering Shaft Bearing Spring
14 Spring Seat
15 Steering Shaft Upper Bearing
16 Steering Column Tube
17 Steering Shaft
18 Horn Cable Guard

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Figure 3—Steering Wheel and Horn Contact Installation

2. Gently turn worm to either extreme left or right position; then back away about one turn.

IMPORTANT: Do not turn worm hard to end of travel with linkage disconnected or ball guides on worm nut may be damaged.

3. Bolt bar previously obtained, to worm shaft yoke (35) and attach spring scale (J-544-01) to bar 10 inches from center of worm. Pulling on spring scale, at right angle to bar, measure pull required to keep worm in motion. Pull required must be within 1-1/2 to 2 pounds, otherwise worm bearing adjustment is required.

NOTE: If any "rough" or "lumpy" action is noted during check, worm bearings are damaged. Steering gear should then be removed, disassembled, and bearings replaced as described later under "Steering Gear Overhaul."

4. Remove upper cover bolts and remove housing upper cover (25). Remove as many shims (26) from between upper cover and housing as required to eliminate all worm end play, when cover is reinstalled and bolts fully tightened. Shims used are 0.002", 0.005", 0.010", and 0.030" thick. A minimum of three 0.002" thick and two 0.005" thick shims should be used.

5. Again check pull, as in Step 3 above, and readjust, if necessary, to obtain proper pull. If adjustment is correct, adjust Pitman shaft lash as described in the following:

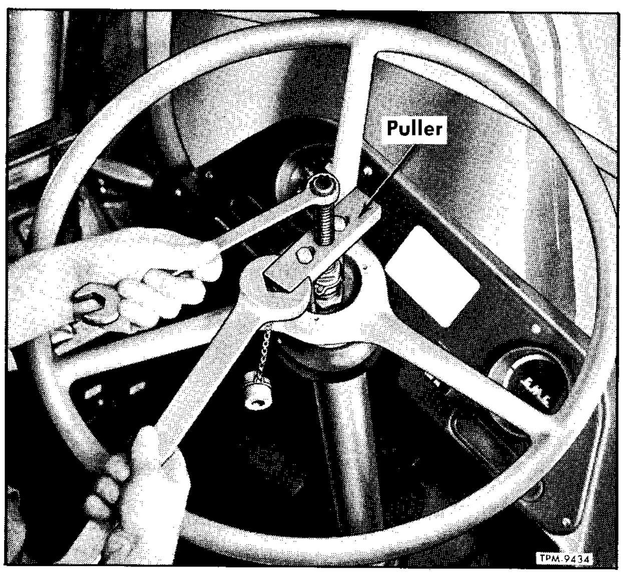


Figure 4—Removing Steering Wheel

PITMAN SHAFT LASH ADJUSTMENT (Fig. 9)

NOTE: Worm bearing adjustment must be completed before making Pitman shaft lash adjustment.

1. Center steering gear by turning worm from extreme right to extreme left position, counting exact number of turns; then rotate worm back exactly half way. Mark worm yoke in some manner to indicate center position.

2. Tighten side cover bolts (3). Turn lash adjuster screw (1) clockwise sufficiently to remove all lash between worm nut teeth and teeth on Pitman shaft sector. Amount of lash may be felt by pushing Pitman arm back and forth. When all lash has been removed, tighten lash adjuster lock nut (2) to 25-35 foot-pounds torque.

3. Check with spring scale as in step 3 under "Worm Bearing Check and Adjustment," except measure greatest pull at CENTER position. If necessary, readjust to obtain pull within 2-3/4 to 3-1/4 pounds.

4. Connect drag link to Pitman shaft, adjusting drag link length, if necessary, as directed under "Drag Link," later in this section.

5. Connect drive shaft universal joint yoke to yoke on worm shaft.

STEERING WHEEL REPLACEMENT

REMOVAL (Figs. 3 and 4)

Key numbers in text refer to figure 3.

1. Remove three screws (10) which attach horn button retainer to steering wheel. Remove retainer, insulator, horn button, terminal plate, and spring from wheel. Lift connector assembly

(8), consisting of contact plate, sleeve, springs, and brush, out of wheel.

2. Remove steering wheel retaining nut (4).

3. Puller screw holes are provided in wheel hub. Using steering wheel puller similar to that illustrated in figure 4, pull steering wheel off shaft.

INSTALLATION

1. Tap Woodruff key (2) into keyseat in shaft. Make sure direction signal cancelling plate (11) is in place on bottom of wheel hub. Position wheel on shaft, with Woodruff key engaging keyway in wheel hub. Install steering wheel retaining nut on shaft. Tighten nut to 40-50 foot-pounds torque.

2. Install contact plate, sleeve, spring, and brush assembly in steering wheel hub, making sure sleeve enters hole in contact shield.

3. Install spring, terminal plate, horn button insulator, and button retainer on wheel and attach with three screws.

STEERING COLUMN AND BEVEL GEAR

REPLACEMENT

REMOVAL (Fig. 1)

1. Remove steering wheel as previously directed under "Steering Wheel Replacement."

2. Refer to LIGHTING (SEC. 7) of this manual for removal of the direction signal housing.

3. Disconnect horn wire. Remove four bolts attaching steering column support flange and seal plate to floor. Lift seal and plate off steering column.

4. Disconnect steering drive shaft universal joint yoke from yoke on lower bevel gear.

5. Remove three bolts attaching steering column bevel gear housing to bracket on frame longitudinal member. Lower bevel gear unit and remove from under vehicle, withdrawing steering column through opening in floor.

INSTALLATION (Fig. 1)

1. Position steering column assembly under vehicle, inserting column up through opening in floor. Attach bevel gear housing to bracket on frame longitudinal member with three bolts, three flat washers, and three lock washers. Use flat washers under bolt heads. Tighten bolts to 90-110 foot-pounds torque.

2. Connect steering drive shaft universal joint yoke to yoke on lower bevel gear. Tighten pinch bolt to torque listed in "Specifications" at end of this section.

3. Install steering column support flange and seal plate over steering column and attach to floor with four bolts. Tighten bolts to torque listed in "Specifications" at end of this section.

4. Install directional signal housing as directed in LIGHTING (SEC. 7) of this manual.

5. Install steering wheel as previously directed under "Steering Wheel Installation."

6. Lubricate bevel gear unit as instructed in LUBRICATION (SEC. 13) of this manual.

STEERING COLUMN AND BEVEL GEAR OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 5.

1. Remove steering wheel as previously described. Remove Woodruff key (48) from slot in steering shaft; then remove bearing spring (46) from shaft and steering column tube.

2. Remove screws attaching horn cable guard to steering column tube. Lift contact and cable assembly off tube.

3. Remove four bolts and lock washers attaching steering column tube and bevel gear housing upper cover assembly (1) to bevel gear housing (15). Lift tube and cover assembly from bevel gear housing. Save shims (6, 7, and 8) used between cover and housing for reuse at assembly.

4. Remove O-ring seal (2) from groove in upper cover (1). Discard seal.

5. While holding steering shaft (38) in a vise with soft jaws, remove pinion gear retaining nut (30) from end of steering shaft (38).

6. Using a brass drift and hammer, tap steering shaft (38) out of pinion gear (31). Remove gear, lower bearing (33), and two bearing races (32 and 34).

7. Remove steering shaft (38) from steering column tube (1).

NOTE: It may be necessary to remove steering shaft upper bearing (15, fig. 3) and spring seat (45) before shaft can be removed.

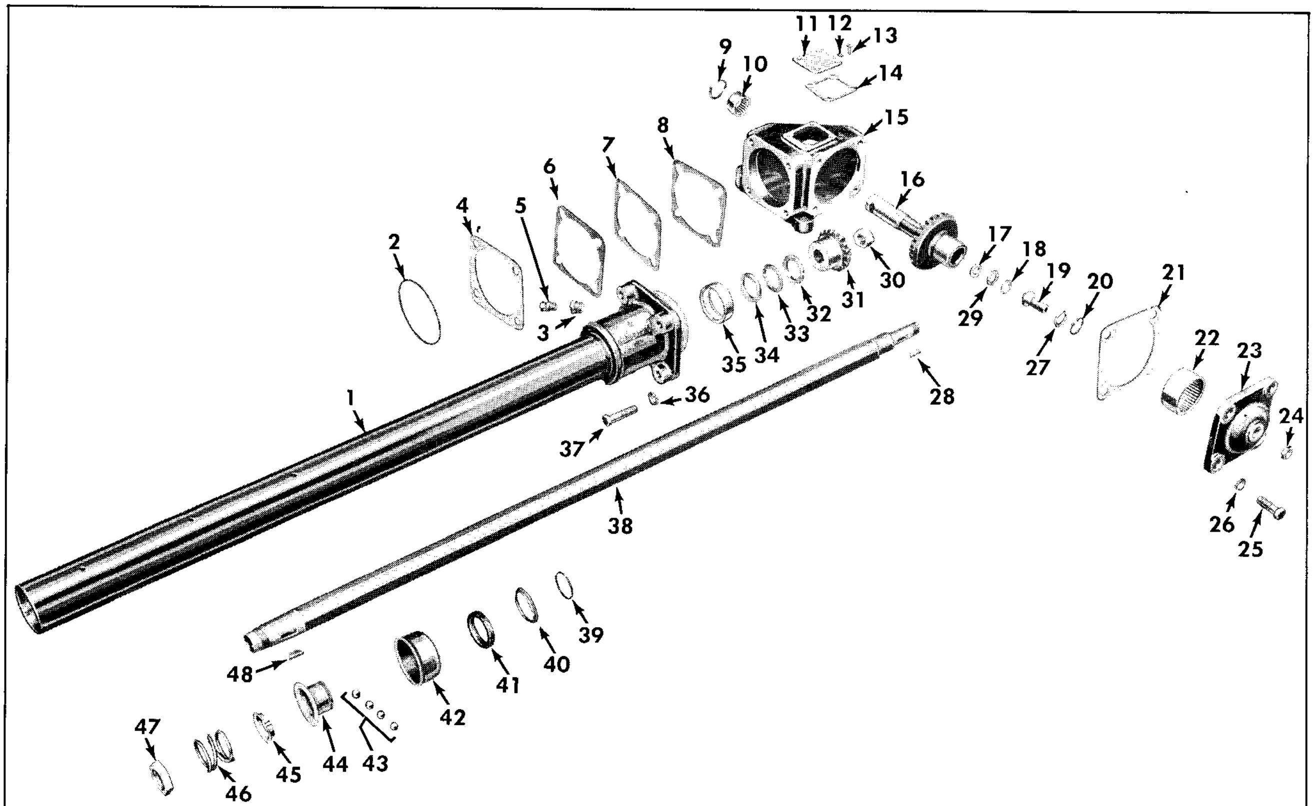
8. If not previously removed in step 7 above, remove steering shaft upper bearing from tube (1), using puller (J-489) (fig. 6).

9. Disassemble upper bearing by removing retainer ring (39); then remove washer (40), packing (41), outer race (42), 14 balls (43), and the inner race (44).

10. With a suitable puller and slide hammer, remove the bearing assembly (35) from bevel gear upper cover (1) (fig. 7).

11. Remove housing vent assembly (5) and reducing bushing (3) from upper cover (1).

12. Remove four bolts and lock washers; then



1 Column Tube and Bevel Gear Housing Upper Cover Assy.
2 Tube to Housing O-ring Seal
3 Vent to Housing Bushing
4 Gasket
5 Steering Column Housing Vent
6 Thick Shim
7 Thin Shim
8 Thick Shim
9 Retainer
10 Bearing
11 Cover Plate
12 Lock Washer
13 Screws
14 Gasket
15 Bevel Gear Housing
16 Bevel Gear
17 Bearing Race
18 Bearing Race
19 Bevel Gear Screw
20 Bearing Retaining Ring
21 Cap to Housing Gasket
22 Housing Cap Bearing Assy.
23 Bevel Gear Housing Cap
24 Bevel Gear Nut
25 Cap to Housing Bolt
26 Lock Washer
27 Washer
28 Woodruff Key
29 Bevel Gear Bearing
30 Pinion Gear to Shaft Nut
31 Steering Shaft Pinion Gear
32 Bearing Race
33 Steering Shaft Lower Bearing
34 Bearing Race
35 Housing Upper Cover Bearing Assy.
36 Lock Washer
37 Upper Cover to Housing Bolt
38 Steering Shaft
39 Retaining Ring
40 Washer
41 Packing
42 Outer Race
43 Balls (14)
44 Inner Race
45 Spring Seat
46 Bearing Spring
47 Steering Wheel Retaining Nut
48 Woodruff Key

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Figure 5—Steering Column and Bevel Gear Components

remove housing cap (23) and bevel gear assembly (16) from bevel gear housing (15). Remove and discard gasket (21).

13. Remove lock nut (24); then using an Allen end wrench, remove adjusting screw (19) and bevel gear assembly (16) from housing cap (23).

14. Remove snap ring (20) from bevel gear shaft (16).

15. Remove thrust screw (19), washer (27), outer and inner race (17 and 18), and bearing (29) from bevel gear shaft (16).

16. Remove bearing race from bevel gear (16) only if inspection shows necessity.

17. Using an arbor press and suitable remover tool, remove retainer seal (9) and bearing (10) from bevel gear housing (15).

18. Remove four screws (13) and lock washers; then remove cover plate (11) and gasket (14) from bevel gear housing (15). Discard gasket.

19. Remove drain plug from bevel gear housing (15).

20. Do not remove bearing (22) from housing

cap (23) unless inspection shows necessity for removal.

CLEANING AND INSPECTION

1. Clean all parts thoroughly in cleaning solvent. Wipe or blow parts dry.
2. Scrape all particles of old gasket off housing upper cover, housing cap, cover plate, and bevel gear housing.
3. Examine steering shaft for bent or twisted condition. Check steering shaft pinion gear for worn or broken teeth.
4. Examine lower bevel gear for worn or broken teeth.
5. Inspect all bearing assemblies for worn or damaged condition. Check bearing races for wear.
6. Replace all parts that are not in first class condition.

ASSEMBLY

Key numbers in text refer to figure 5.

1. Using an arbor press and suitable sleeve, press bearing assembly (22) into bore of bevel gear housing cap (23) if bearing was previously removed.
2. With press and suitable sleeve, press bearing assembly (10) and retainer seal (9) into bore of bevel gear housing (15).
3. Install drain plug in bore of bevel gear housing (15).
4. If bearing race was removed from bevel gear shaft (16) during inspection procedures, press new race on shaft.
5. Position bevel gear in vise with soft jaws and install inner race (17), bearing (29), outer race (18), adjusting screw (19), washer (27), and snap ring (20) in bore of bevel gear shaft (16).
6. Position housing cap assembly (23) on end of bevel gear (16); then using an Allen end wrench, turn cap on shaft. Install lock nut (24) on bevel gear adjusting screw (19) loosely. Nut is to be tightened later in step 18.
7. Place new gasket (21) over bevel gear (16) and against housing cap (23); then install bevel gear and cap assembly in bevel gear housing attaching with four bolts and lock washers. Tighten bolts to 20-25 foot-pounds torque. NOTE: Side of cap with corners cut off goes toward bottom of housing.
8. Install Woodruff key (28) in slot in lower end of steering shaft (38).
9. With suitable sleeve and hammer, tap bearing assembly (35) into housing upper cover (1).
10. Insert steering shaft (38) through top of column tube (1) and install bearing race (34), bearing (33), and second race (32) over steering shaft and into bore of housing upper cover.
11. Using a plastic hammer, tap steering shaft pinion gear (31) on lower end of steering shaft.

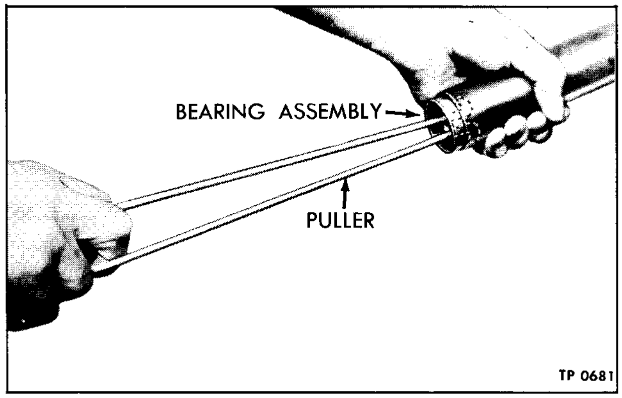


Figure 6—Removing Steering Shaft Upper Bearing

Install retaining nut (30) on shaft, tighten nut to 40-50 foot-pounds torque.

12. Install reducing bushing (3) and vent assembly (5) in bore of housing upper cover.
13. Assemble steering shaft upper bearing as follows: Place inner race (44) in palm of hand and lubricate inner race to hold bearing balls. Line fourteen balls (43) around the race; then install race and balls in outer race (42). Position packing (41) and retainer washer (40) on end of outer race; then install the retaining snap ring (39).
14. Press or tap upper bearing assembly into steering column tube over steering shaft.
15. Install spring seat (45) and spring (46) in tube over shaft and install Woodruff key (48) in slot of steering shaft. Retain parts with steering wheel nut (47).
16. Install new O-ring seal (2) in groove of upper cover (1) and position original pack of shims (6, 7 and 8) against the cover.

NOTE: Approximately two thick shims and one thin shim are required to maintain proper adjust-

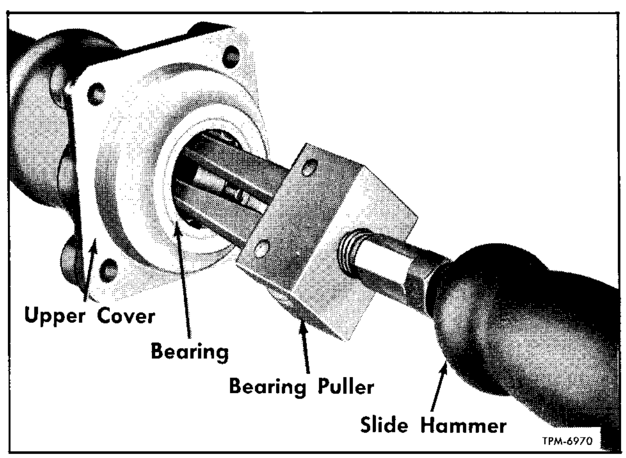
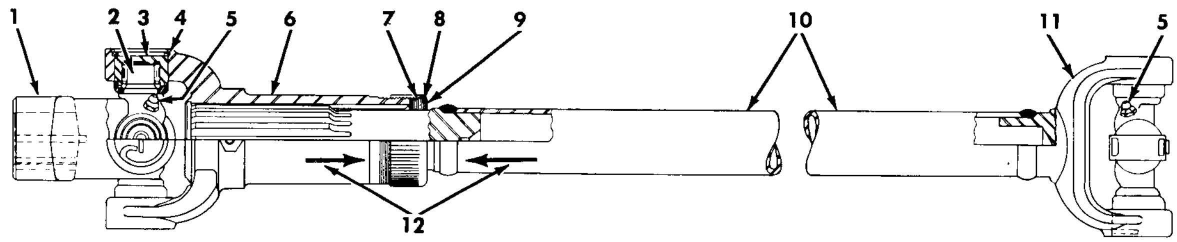


Figure 7—Removing Bearing from Upper Cover



1 End Yoke
2 Journal Cross
3 Bearing
4 Snap Ring
5 Lubrication Fitting
6 Slip Joint Sleeve Yoke
7 Cork Washer
8 Steel Washer
9 Dust Cap
10 Propeller Shaft Tube
11 Fixed Joint
12 Arrows Must Be In Line - They Align Trunnions

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Figure 8—Steering Drive Shaft

ment. Thin shims must be placed between thick shims. Shims are 0.003" and 0.010" thick.

17. Install bevel gear housing assembly on steering column and upper cover assembly attaching with four bolts and lock washers. Tighten bolts alternately and evenly, to 25-30 foot-pounds torque.

18. Check back lash of bevel gears. Maximum allowable backlash is 0.002". Revolve gears to make sure there is no perceptible bind at any point. If gears are meshed too tight, hard steering will result. If gears are too loose, operation will be rough and noisy with excessive steering wheel play. To adjust gear lash, thread bevel gear adjuster screw (19) in or out as necessary to obtain proper gear lash; then tighten lock nut (24) securely.

19. Install new gasket (14) and cover plate (11) on bevel gear housing attaching with four screws and lock washers. Tighten screws firmly.

STEERING DRIVE SHAFT

REPLACEMENT

REMOVAL (Refer to Fig. 1)

1. Remove lock nuts and U-bolts attaching the drive shaft to yoke on steering gear worm shaft. Remove drive shaft from steering gear.
2. Remove bolt and lock nut attaching drive shaft to steering column bevel gear shaft.
3. Tap drive shaft loose from bevel gear shaft with a soft hammer. Remove drive shaft.

INSTALLATION (Refer to Fig. 1)

1. Position drive shaft yoke on bevel gear shaft making sure Woodruff key is installed in slot of bevel gear shaft.
2. Install bolt and lock nut. Tighten to torque listed in "Specifications" at end of this section.
3. Align drive shaft yoke with yoke on steering gear worm shaft; then install U-bolts and lock nuts. Tighten nuts to torque listed in "Specifications" at end of this section.

DRIVE SHAFT OVERHAUL

DISASSEMBLY (Fig. 8)

1. Before disassembly of drive shaft, look for alignment arrows (12) on shaft and slip joint sleeve. If arrows are not readily discernible, mark both parts so they can be reassembled in exactly the same relative positions.
2. Unscrew dust cap (9) from slip joint sleeve and pull slip joint assembly (6) off tube (10). Slide dust cap off tube. Remove cork (7) and steel washer (8) from dust cap.

Succeeding steps cover disassembly of universal joint at either the slip joint or fixed end of shaft.

3. Remove snap rings (4) from ends of yokes
4. Strike hub of yoke in line with bearings (3) to force bearing out of yoke far enough to be withdrawn by hand. Turn assembly over and force out opposite bearing. Repeat procedures until all four bearings are removed.
5. Slide journal cross (2) sideways until it clears one side of yoke, tilt at extreme angle, and withdraw from opposite side of yoke. Remove journal from other yoke in same manner.
6. Remove lubrication fitting from journal.

CLEANING AND INSPECTION

1. Clean all parts in a suitable cleaning solvent. Make sure lubricant passages in journal are

clean. Soak needle bearing assemblies in cleaning solvent to loosen old lubricant, clean with stiff bristled brush, and blow out with compressed air.

2. Inspect bearing surfaces of journals for roughness. If journals will not clean up with moderate honing, journal should be replaced. When new journal is used, new bearings should also be used. Carefully inspect each bearing assembly for damage or missing rollers. Excessive wear is indicated if rollers drop out of retainer, or if journal bearing surfaces show marks of rollers.

3. After bearings are clean, pack with lubricant recommended in LUBRICATION (SEC. 13). Place bearings on journal and check for wear (looseness). If excessive clearance is indicated, replace journal or bearings, or both.

ASSEMBLY

1. Install lubrication fittings (5) in journals if previously removed.

2. Insert one end of journal into yoke as far as possible from inside; then tilt journal until opposite side of journal will drop into other side of yoke. Install journal in other yoke in same manner.

3. Install bearings (3) in yokes over ends of journal, tapping bearings into place with a rawhide or plastic hammer if necessary. Install new snap rings (4) to secure bearings in yokes. Make sure snap rings are fully seated in grooves.

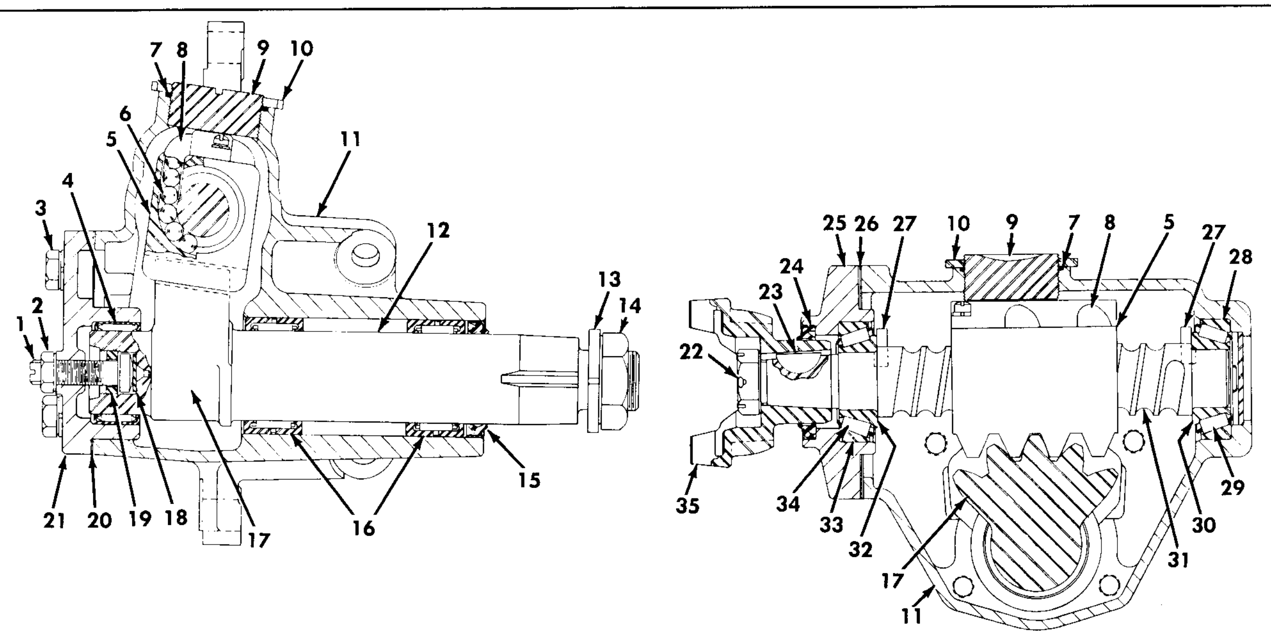
4. Repeat these procedures to install journal and bearings at opposite end of drive shaft.

5. Install steel washer (8) and new cork washer (7) in dust cap (9); then position dust cap and washers on drive shaft tube (10).

6. Insert tube (10) into slip joint sleeve, making sure arrows (12) or marks made prior to disassembly are aligned.

7. Thread dust cap onto slip joint sleeve and tighten by hand.

STEERING GEAR ASSEMBLY



1 Lash Adjuster Screw
2 Lock Nut
3 Side Cover Bolt
4 Pitman Shaft Side Cover Bearing
5 Worm Ball Nut
6 Worm Balls
7 Back-up Adjuster Packing
8 Ball Guide
9 Back-up Adjuster
10 Back-up Adjuster Lock Nut
11 Steering Gear Housing
12 Pitman Shaft
13 Lock Washer
14 Pitman Arm Nut
15 Pitman Shaft Oil Seal
16 Pitman Shaft Housing Bearings
17 Pitman Shaft Sector Gear
18 Lash Adjuster Thrust Washer
19 Lash Adjuster Retainer
20 Side Cover Gasket
21 Housing Side Cover
22 End Yoke Nut
23 End Yoke Key
24 Steering Shaft Oil Seal
25 Housing Upper Cover
26 Bearing Adjusting Shims
27 Ball Nut Stops
28 Worm Bearing Cup - Lower
29 Worm Bearing - Lower
30 Worm Bearing Cone - Lower
31 Steering Shaft Worm
32 Worm Bearing Cone - Upper
33 Worm Bearing Cup - Upper
34 Worm Bearing - Upper
35 Steering Shaft End Yoke

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Figure 9—Steering Gear Assembly

MECHANICAL STEERING

STEERING GEAR REPLACEMENT

REMOVAL (Fig. 1)

1. Disconnect propeller shaft universal joint yoke from yoke on steering gear worm shaft.
2. Disconnect the drag link from Pitman arm; then remove Pitman arm retaining nut and lock washer. Pull Pitman arm off shaft, using puller (J-21143) or other suitable puller.
3. Remove forward nut and lock washer from right-hand support U-bolt. Remove nuts and lock washers from two left-hand support studs. Remove two bolts and lock washers located in gear housing flange at forward side of the axle center.
4. Lift steering gear assembly up off studs and move forward off axle.

INSTALLATION (Fig. 1)

NOTE: Be sure front wheels and steering wheel are in the straight-ahead position, and that key slot in steering gear worm shaft is in 12 o'clock position before installing the steering gear.

1. Position steering gear assembly on front axle, with two left-hand support studs and front end of right-hand support U-bolt engaging holes in steering gear housing flanges.
2. Install nuts and lock washers on studs. Tighten nuts to torque listed in "Specifications" at end of this section.
3. Install nut and lock washer on front right-hand U-bolt. Tighten nut to torque listed in "Specifications" at end of this section.
4. Install two gear housing to front axle beam bolts in gear housing flange at front side of axle. Tighten bolts on all coaches to 170-180 foot-pounds torque.

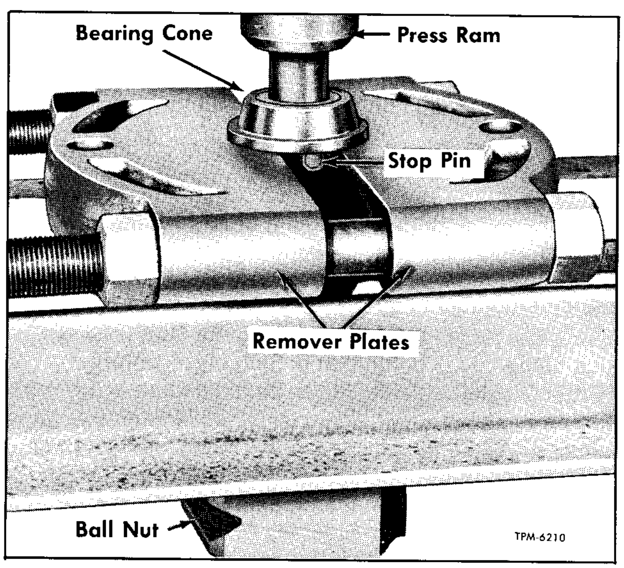


Figure 10—Removing Lower Worm Thrust Bearing Cone

5. Position Pitman arm on steering gear Pitman shaft. Install lock washer and nut securing arm to shaft. Tighten nut to torque listed in "Specifications" at end of this section.
6. With front wheels and steering wheel in straight-ahead position, move Pitman arm to a position where centerline of hole at drag link end of arm is 1.74" to left of centerline of coach on TDH-4516, TDH-5301 and TDM-5301 coaches. On TDH/TDM-4517, SDH/SDM-4501, SDH/SDM-5301, and TDH/TDM-5302 coaches, position centerline of hole at drag link end of arm 1.26" to right of centerline of coach.

NOTE: Centerline of coach can be identified by prick punch marks on rear side of front axle beam.

7. With front wheels, steering wheel, and Pitman arm positioned as described in step 6 above, install end stud on drag link in hole in Pitman arm. Install stud nut and tighten to 150 foot-pounds torque minimum and advance to next cotter pin slot. Install new cotter pin.
8. Connect propeller shaft universal joint yoke to yoke on steering gear worm, using two U-bolts and lock nuts. Tighten lock nuts to torque listed in "Specifications" at end of this section.
9. Lubricate all points in steering system as instructed in LUBRICATION (SEC. 13).

STEERING GEAR OVERHAUL

DISASSEMBLY

NOTE: Key numbers in text refer to figure 9. Steering gear parts must be kept free from dirt or other foreign matter during overhaul procedures.

1. Remove plugs and drain as much lubricant as possible from the housing.
2. Mount steering gear assembly in a vise or holding fixture with the worm shaft horizontal. Do not grip the housing too tightly in vise.
3. Loosen lock nut (10); then remove back-up adjuster (9), packing, and lock nut. Discard packing (7).
4. Remove vent assembly from housing. Remove cotter pin and nut (22) attaching propeller shaft yoke (35) to steering gear worm (31); pull yoke off worm.
5. Remove lock nut (2) from lash adjuster screw (1). Remove four bolts and lock washers attaching side cover (21) to housing. Remove side cover and bearing assembly (4), using a screwdriver to thread lash adjuster screw out of cover as cover is withdrawn. Remove and discard side cover gasket (20).
6. Make sure the worm shaft (31) is horizontal and rotate shaft as necessary to position sector gear (17) on Pitman shaft (12) so it will pass through opening in gear housing; then withdraw Pitman shaft (12) from gear housing.

NOTE: Horizontal position of the worm shaft is necessary to prevent ball nut (5) from running down to end of worm as Pitman shaft (12) is withdrawn, thereby damaging the ball return guides.

7. Remove four bolts and lock washers attaching top cover (25) to housing (11); then carefully withdraw top cover, worm, and ball nut assembly as a unit. Remove lower worm thrust bearing (29).

8. Remove top cover (25) from worm shaft (31). Remove upper thrust bearing (34) from top cover (25). Retain shim pack (26) for reassembly of steering gear.

IMPORTANT: Do not hold worm shaft (31) in a vertical position as ball nut (5) will travel by its own weight to end of shaft. If ball nut sharply strikes either end of shaft worm, ball guides (8) will be damaged.

9. Try action of ball nut (5) on shaft worm (31). Ball nut must rotate smoothly with no evidence of binding or roughness. Tape shaft worm at both ends of ball nut to keep nut from running up or down; then lay the assembly flat on work bench until ready to disassemble.

10. Remove lower thrust bearing cone (30) from worm shaft (31), using bearing remover plates (J-8176) (fig. 10).

11. Remove lower ball nut pin stop (27).

12. Remove screws attaching ball guide clamp to ball nut (5). Remove clamp. Pull ball guides out of ball nut as shown in figure 11. Remove balls (6) from guides by separating guides.

13. Remove tape from shaft worm; then turn ball nut upside down over a clean pan and rotate worm shaft back and forth until all balls have been removed. Pull ball nut endwise from worm shaft.

14. Remove upper thrust bearing cone (32) from worm shaft (31), using bearing remover plates (J-8176). Refer to figure 10. Remove upper ball nut stop pin (27) from worm shaft.

15. Remove Pitman shaft oil seal (15) from gear housing (11) and discard.

16. Remove worm shaft oil seal (24) from top cover (25) and discard. New oil seals should be used when reassembling the steering gear.

17. Removal of lower worm thrust bearing cup (28) from housing, upper thrust bearing cup (33) from top cover, needle bearing (4) from side cover, and needle bearings (16) from housing should be deferred until inspection of parts indicate necessity for further disassembly.

CLEANING AND INSPECTION

1. Wash all parts thoroughly in suitable cleaning solvent and wipe or blow parts dry prior to inspection, repair, and reassembly of the steering gear. Procedures should not be attempted in dirty surroundings. Parts must be absolutely clean.

2. Inspect steering gear housing and side cover for cracks, distortion, and condition of threads in tapped holes. Replace parts if damaged.

3. Examine needle roller bearings in housing and side cover for cracked, chipped, or worn rollers. If worn or damaged, bearing assemblies must be replaced as directed later under "Pitman Shaft Bearing Replacement."

4. Inspect Pitman shaft sector teeth and mating worm nut teeth for wear or damage. Check Pitman shaft for wear at bearing surfaces. If excessive wear is evident, replace shaft. Check condition of threads on lash adjuster screw, and check amount of screw end play in shaft. Any damage will necessitate replacement of lash adjuster screw; however, if screw is only loose (more than 0.005" end play), an adjustment may be made. Replacement and adjustment instructions are given later under "Lash Adjuster Replacement and Adjustment."

5. Inspect worm tapered roller bearing assemblies for worn or damaged rollers; also inspect bearing cups in top cover and housing and upper and lower bearing cones for wear or damage. If either the bearing rollers, cups, or cones are damaged, replace with complete new bearing assemblies. Instructions for replacing bearing cups are given later under "Worm Thrust Bearing Cup Replacement."

6. Inspect steering worm shaft for scoring, distortion, or wear.

7. Examine ball nut for scuffing, scoring, or wear on rack teeth and on ball thread groove. Check all holes and passages for obstructions. Check worm balls for flat spots, checking, wear, or damage. Balls should all be the same size within 0.0001".

8. Check expansion plug in housing for looseness or signs of grease leakage. If apparent, replace plug as follows:

a. Remove plug from housing by pressing center of plug outward from housing. As curvature of plug is changed, it will become loose and can easily be removed without damage to housing.

b. While expansion plug is removed, check condition of lower worm thrust bearing cup. Re-

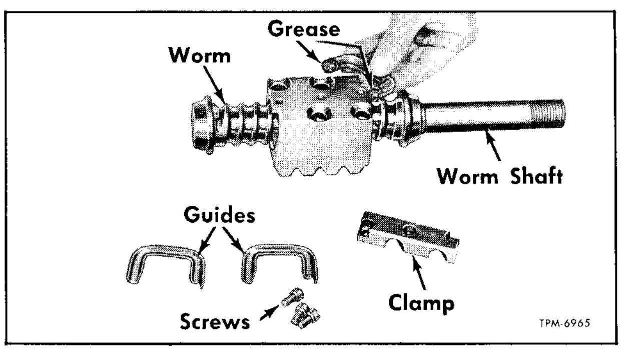


Figure 11—Ball Guide Removal and Installation

MECHANICAL STEERING

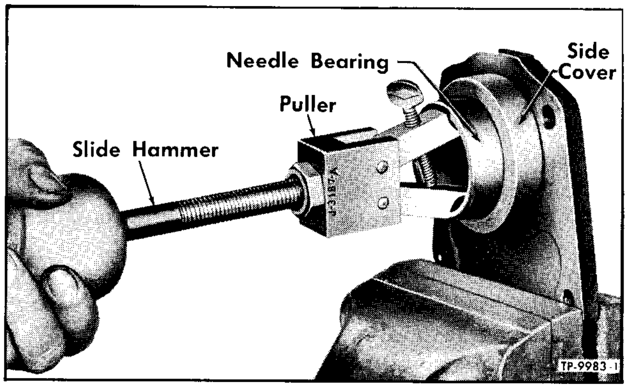


Figure 12—Removing Side Cover Needle Bearing

place if necessary, as described later under "Worm Thrust Bearing Cup Replacement."

c. Position new expansion plug in gear housing with convex side facing out. Press on center of plug to deform it inward to secure in housing.

9. Inspect ball return guides for distortion or damage. Place two halves of a guide together and try action of balls in guide. Replace guides if any restriction exists. Check return guide clamp.

10. Check top cover for cracks or damage.

STEERING GEAR REPAIR

PITMAN SHAFT BEARING REPLACEMENT

NOTE: Key numbers in text refer to figure 9.

When inspection indicates the need of replacing

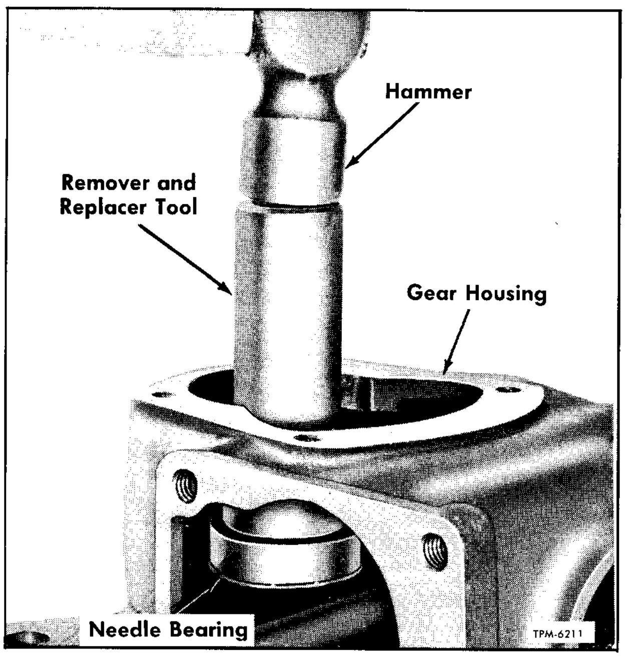


Figure 13—Removing or Installing Needle Bearing in Housing

Pitman shaft needle roller bearings (4 and 16) in housing and side cover, it is recommended that suitable tools be used to remove and replace bearings to avoid damage to the bearings and steering gear housing.

1. Pull needle bearing from side cover, using puller tool (J-3187-A) with slide hammer (J-2619) (fig. 12).

2. Press or drive needle bearings from steering gear housing, using remover and replacer tool (J-5529) (fig. 13).

3. Install bearings in both side cover and gear housing with remover and replacer tool (J-5529). During installation, press only against the stamped identification side of bearing. Press side cover bearing in flush with face of side cover.

WORM THRUST BEARING
CUP REPLACEMENT

1. Using a suitable punch and hammer, drive bearing cup (28) from steering gear housing.

2. Position new bearing cup squarely over recess in gear housing and press cup in until it is firmly and evenly seated. Use old cup to press new cup into place.

3. Repeat these procedures for top cover bearing cup (33) replacement.

LASH ADJUSTER REPLACEMENT
AND ADJUSTMENT

1. Lash adjuster retainer is tack-welded in end of Pitman shaft (fig. 14). Break tack-weld and withdraw retainer from shaft. Remove adjuster screw and thrust washer.

2. Install a new thrust washer and adjuster screw, lubricating end of adjuster screw with recommended steering gear lubricant.

3. Screw retainer in tight; then back off 30 degrees to obtain correct adjustment. Tack-weld retainer at points shown in figure 14.

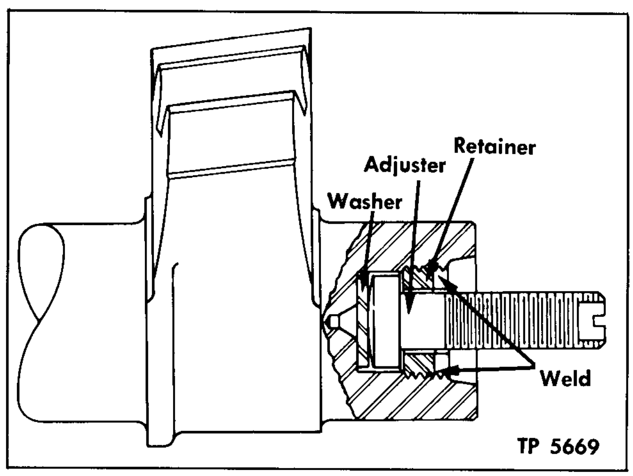


Figure 14—Installation of Lash Adjuster Screw

ASSEMBLY OF STEERING GEAR

(Key Numbers in Text Refer to Figure 9)

GENERAL

One of the most important phases when assembling the steering gear is cleanliness. All parts must be kept clean. Any bits of abrasive material which may get inside the housing during assembly procedures will quickly damage the gear mechanism. Grease and oil used at assembly must be free from dirt. When handling parts, make certain that hands are clean and that clean cloths are used. Pre-lubricate all bearings, oil seals, and moving parts at assembly with proper lubricant specified in LUBRICATION (SEC. 13) of this manual.

ASSEMBLING BALL NUT AND WORM

1. Install worm ball nut over shaft worm with return guide holes in ball nut up. Align grooves in worm and ball nut by sighting through bottom of ball return guide holes.
2. Divide total number of balls into two clean containers (42 balls for each circuit).
3. Drop balls into one of the return guide holes in upper circuit of nut. Gradually turn shaft away from that hole while inserting balls. Continue until the circuit is filled from bottom of one hole to bottom of the other, or until stopped by reaching end of the shaft worm (fig. 15).
4. In event balls are stopped by reaching end of shaft worm, hold down balls already installed with a rod or punch in return guide hole (fig. 15). Turn shaft in the reverse direction a few turns. Filling of the circuit can then be continued. It may be necessary to work shaft back and forth, holding balls down, first in one hole and then in the other. This will close up spaces between balls, filling the circuit completely and solidly.
5. Lay one-half of a ball guide on bench with groove up. Place the remaining balls for the first circuit into groove of the guide (fig. 16). Close this half of ball guide with other half. Hold the two halves together and plug each open end with heavy grease as shown in figure 11, to prevent balls from dropping out.
6. Push ball return guides, with balls, completely into return holes in ball nut. Tap guide lightly with screwdriver handle to seat if necessary. This completes one circuit of balls.
7. Fill lower ball circuit in ball nut in same manner as described for upper ball circuit.
8. Install ball return guide clamp on ball nut, using the three screw and lock washer assemblies. Tighten screws securely.
9. Thoroughly lubricate ball nut and balls; then test assembly by rotating ball nut on shaft worm. Do not rotate ball nut to end of worm threads as this may damage ball guides. If motion of worm nut is not free, cause of bind must be located and trouble corrected. Bent ball guides may restrict ball circuit travel.
10. Temporarily tape shaft worm at both ends of ball nut to keep nut from running up or down; then until ready to install in gear housing, lay the assembly flat on work bench.

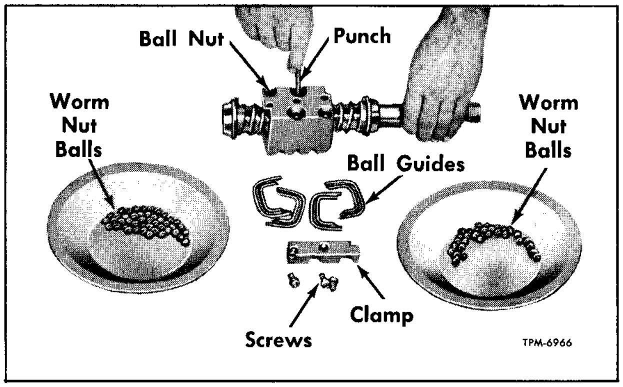


Figure 15—Filling Ball Circuit in Nut

INSTALLATION OF WORM, BALL NUT, AND TOP COVER ASSEMBLY

1. Lubricate new worm oil seal (24) and press in base of top cover. Seal should be positioned so that lip of seal faces toward steering gear housing.
2. Install ball nut upper stop pin (27) in worm shaft slot.
3. Press upper thrust bearing cone (32) on worm shaft, using bearing installer plates (J-8176).
4. Install ball nut lower stop pin (27) in slot in worm shaft.
5. Press lower thrust bearing cone (30) on worm shaft, using bearing installer plates (J-8176).
6. Mount steering gear housing in holding fixture or vise so that top cover opening is up. Do not grip too tightly.
7. Lubricate worm thrust roller bearing (29) and position in cup (28) in lower end of gear housing.

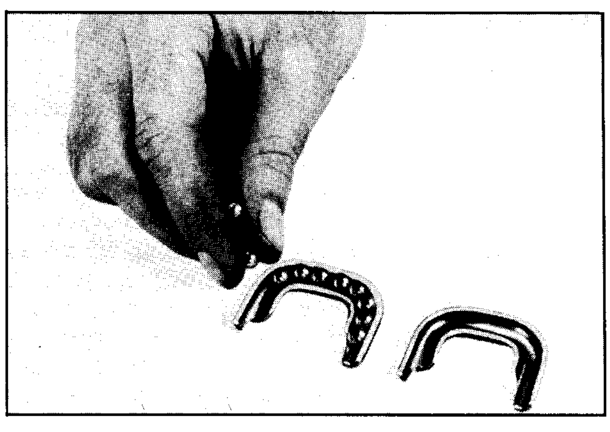


Figure 16—Filling Ball Guides

8. Place original pack of shims (26) on top cover (25). Shims are available in 0.002", 0.005", 0.010", and 0.030" thickness. A minimum of three 0.002" and two 0.005" shims must be used for initial adjustment.

9. Lubricate upper worm thrust bearing (34); then position bearing on upper end of worm shaft over upper cone (32). Place top cover (25) over shaft and on bearing.

10. Remove tape from shaft worm at both ends of the ball nut; then gently rotate ball nut assembly so that it contacts stop pin (27) in lower end of the worm.

11. Lift top cover, worm, and ball nut assembly by grasping top cover and worm. Turn the shaft into a vertical position so that ball nut is on the bottom. Carefully guide the assembly into gear housing until bearing cone (30) on worm shaft contacts lower worm thrust bearing (29). In so doing, rotate the worm so ball nut return guide clamp faces the back-up adjuster opening in the housing. Bolt top cover to gear housing. Tighten bolts to 35-45 foot-pounds torque.

12. Accomplish all procedures described in steps 1 through 10 under "Installation of Pitman Shaft and Side Cover" following:

INSTALLATION OF PITMAN SHAFT AND SIDE COVER

1. With gear housing positioned in vise or holding fixture so that worm shaft (31) is horizontal, proceed as follows:

2. While holding worm nut (5), turn worm shaft to move nut to center of worm, This is necessary so that worm nut and Pitman shaft will mesh properly when the shaft is installed. Center tooth on Pitman shaft sector (17) must enter center space in worm nut (5).

3. Apply proper lubricant to shaft bearings (16) in gear housing. Position Pitman shaft in gear housing, being careful not to damage bearings with serrated end of the shaft.

4. Position a new gasket (20) on gear housing side cover opening.

5. Apply proper lubricant to side cover bearing (4). Place side cover on lash adjuster screw (1) in Pitman shaft. With screwdriver through hole in side cover, thread lash adjuster screw through cover until cover is pulled against housing. Back off lash adjuster screw a few additional turns to provide backlash between sector gear (17) on shaft and ball nut (5).

6. Install side cover to housing attaching bolts (3) and lock washers. Tighten bolts to 25-35 foot-pounds torque. Install adjuster screw lock nut (2) loosely.

7. Install new Pitman shaft oil seal (15) carefully over Pitman shaft so that serrations on shaft do not damage seal. Lips of oil seal should face inside of gear housing. Be sure oil seal is well seated in housing. Tool used to install bearing in housing may be used to install oil seal.

8. Install back-up adjuster, new packing, and lock nut loosely in the gear housing. Do not make adjustment until all other adjustments have been made.

9. Tap Woodruff key (23) into key slot in worm shaft and install drive shaft yoke (35). Secure yoke on worm shaft with nut and cotter pin.

10. Install bushing and lubrication fitting in tapped boss in bottom of gear housing. Fill gear housing with proper lubricant as described in LUBRICATION (SEC. 13) of this manual.

11. Install the steering gear assembly in coach as described earlier in this section under "Steering Gear Replacement."

12. Adjust worm bearings, and make Pitman shaft lash adjustment as previously directed in this section under "Steering Gear Adjustments."

13. Tighten back-up adjuster (9) until adjuster bottoms against ball nut return guide clamp. Back off adjuster 1/4 turn and secure in place with adjuster lock nut. Tighten lock nut to 30-50 foot-pounds torque. Purpose of the back-up adjuster is to keep the worm shaft from flexing up and down.

STEERING DRAG LINK

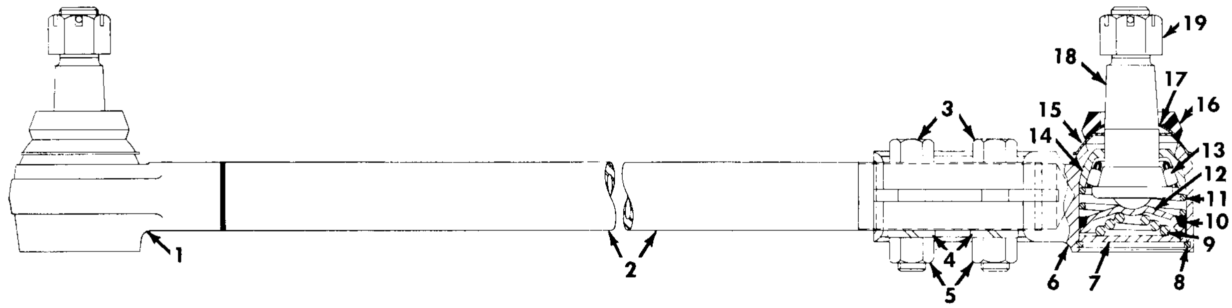
DESCRIPTION

Steering drag link assembly is a two piece type, comprised of drag link and end socket, and an end socket assembly. As shown in figure 17, drag link end sockets are roller bearing type and incorporate an adjustment feature which automatically compensates for wear on bearing surfaces. Both end socket assemblies are identical, except that end socket at Pitman arm screws onto drag link to provide for length adjustment, while end socket at steering arm is integral with link. Drag link end socket at Pitman arm is retained on drag link with clamp bolts. Drag link installation is shown in figure 1.

MAINTENANCE

Linkage between steering gear and front axle definitely affects steering action if parts are out of adjustment, bent, or twisted. Check steering geometry and front wheel alignment as directed in FRONT AXLE (SEC. 1) when steering linkage is repaired or replaced.

Drag link end stud nuts must be kept tight or stud holes in steering arm and Pitman arm may



1 End Socket
2 Drag Link Tube
3 Socket Clamp-Bolt
4 Lock Washers
5 Nuts
6 End Socket
7 Plug
8 Plug Lock
9 Seat Spring
10 Grease Retainer
11 Socket Centering Spring
12 Stud Seat
13 Stud Bearing
14 Bearing Race
15 Inner Dust Cover Washer
16 Dust Seal
17 Outer Dust Cover Washer
18 End Stud
19 Stud Nut

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Figure 17—Steering Drag Link Assembly

become enlarged as a result of excessive looseness. Subsequent tightening of stud nuts may draw studs into arms so far that dust cover parts may be damaged during sharp turns.

Drag link end sockets are equipped with lubrication fittings and should be lubricated as directed in LUBRICATION (SEC. 13).

LENGTH ADJUSTMENT

It should not be necessary to alter length of drag link except when new link is installed or when removable end socket has been removed for overhaul. If necessary to adjust drag link length, proceed as follows:

1. Position front wheels in straight-ahead position.
2. Remove drag link ends from Pitman arm and steering arm.
3. Locate center of steering movement by turning steering wheel from extreme right to extreme left, counting the number of turns; then back up exactly half way.
4. Check position of Pitman arm. Refer to "FRONT END ALIGNMENT" (SEC. 1) of this manual.
5. Connect fixed drag link end to steering arm.
6. Stud at adjustable end of drag link should fit in Pitman arm without changing position of Pitman arm or front wheels.
7. If parts do not assemble correctly, first check all linkage for bends or distortion. If none of the drag link parts are found to be bent or twisted, loosen clamp bolts; then turn drag link end socket enough to obtain length to permit installation of end stud in Pitman arm without twist or bind.
8. Tighten clamp bolts to 45-55 foot-pounds torque; then test adjustment. Front wheels should turn from right to left extremes without noticeable binding at drag link ends.

REMOVAL AND DISASSEMBLY

Key numbers in text refer to figure 17.

Normal wear on bearing surfaces in drag link end socket will result in increased overall height of the assembly. If excessive play is noted, drag link end sockets must be disassembled for replacement of worn parts.

1. Disconnect drag link ends from steering arm and Pitman arm by removing cotter pins and nuts from end studs and driving studs out of arms.
2. Loosen clamp bolt nuts and unscrew drag link end from drag link at Pitman arm end.
3. Remove dust seal (16), dust cover washer (17), inner dust cover washer (15) from stud end (18).
4. Pry end plug lock wire (8) out of drag link end socket (6); then remove end plug (7), end stud seat spring (9), end stud seat (12), grease retainer (10), socket centering spring (11), end stud (18), end stud bearing (13), and end stud bearing race (14) from drag link end socket.

CLEANING AND INSPECTION (Fig. 17)

1. Immerse all parts, except dust seal in a suitable cleaning solvent. Use a stiff bristle brush, as required, and clean parts thoroughly.
2. Check all parts for wear or corrosion and discard parts that are badly damaged.
3. Check tension of end stud seat spring (9) and centering socket spring (11). Discard springs if tension is not within limits. Refer to "Specifications" at end of this section.
4. Carefully inspect rollers in end stud bearing assembly (13) for roughness or flaking. If roll-

ers will not rotate freely in bearing race (14), bearing assembly should be replaced.

ASSEMBLY AND INSTALLATION (Fig. 17)

Keep all parts clean when performing assembly operations. If dirt or grit is allowed to get into drag link end socket when assembling, premature and excessive parts wear will result.

1. Lubricate all parts with lubricant specified in LUBRICATION (SEC. 13); then place end stud bearing (13) and end stud bearing race (14) on end stud (18).

2. Insert stud and bearing assembly into drag link end socket (6); then press grease retainer (10) over stud seat (12). Place centering socket spring (11) and stud seat (12) in drag link end; then install end stud seat spring (9) and end plug (7). Secure parts in drag link end socket (6) with end plug lock wire (8).

3. Install on threaded end of stud, in following order, inner dust cover washer (15), outer dust cover washer (17), and dust seal (16).

4. Install drag link end assembly on drag link, but do not tighten clamp bolt nuts.

5. Install drag link and adjust length as previously directed under "Length Adjustment" in this section; then lubricate as directed in LUBRICATION (SEC. 13).

STEERING TIE ROD

DESCRIPTION

Tie rod assembly is a three-piece type comprised of tube and two socket end assemblies. Tube is threaded into socket ends and locked with clamp bolts. Right- and left-hand threads are provided to facilitate toe-in adjustment.

Tie rod end sockets (fig. 18) are so constructed as to automatically compensate for wear at bearing surfaces. Tie rod end parts are replaceable. Snap ring and plug can be removed from tie rod end socket to permit removal of stud, bearing, and bearing seat.

TIE ROD REMOVAL AND DISASSEMBLY

Key numbers in text refer to figure 18.

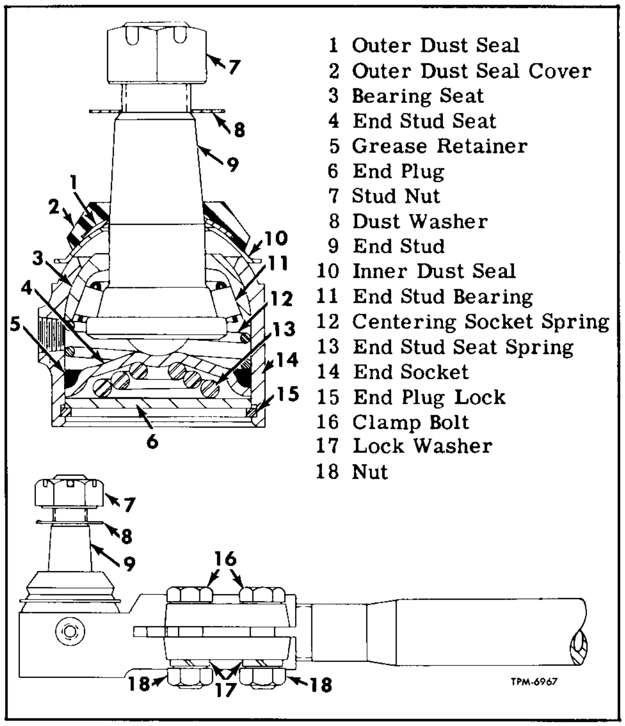


Figure 18—Tie Rod Construction

1. Remove cotter pins and nuts from tie rod ends, support steering arm to prevent bending; then drive tie rod end tapered studs out of steering arms. Remove dust washer (8), outer dust seal cover (2), outer dust seal (1), and inner dust seal (10) from stud.

2. Loosen clamp bolts; then remove each tie rod end socket assembly from tube.

3. Pry end plug lock (15) out of tie rod socket end; then remove plug (6), spring (13), stud seat (4), and grease retainer (5). Stud (9), bearing (11), centering spring (12), and bearing seat (3) can then be removed from the end socket (14).

TIE ROD INSPECTION

Clean all tie rod parts thoroughly; then inspect for wear and other damage. Discard worn parts and replace springs in tie rod ends if found to be weak or broken. Straighten or replace tie rod tube if bent.

TIE ROD ASSEMBLY AND INSTALLATION

Key numbers in text refer to figure 18.

1. Lubricate tie rod end parts with lubricant specified in LUBRICATION (SEC. 13) before assembling.

2. Place bearing seat (3) in tie rod socket (14); then place bearing (11) and stud (9) in socket. Follow with centering spring (12) and grease retainer (5).

3. Install stud seat (4) and seat spring (13); then secure parts in socket with plug (6) and lock (15).

4. Install tie rod end sockets on tube, threading each socket the same number of turns on tube; then install clamp bolts.

5. Assemble dust shield parts on end studs in the following order: inner dust seal (10), outer dust seal (1), outer dust seal cover (2), and dust washer (8).

6. Install tie rod assembly on steering arms with lubrication fittings toward the rear. Tighten

stud nuts to minimum torque; then tighten nuts as necessary to permit installation of new cotter pins.

NOTE: Final adjustment of the tie rod assembly for setting toe-in should be made after the front axle is installed on coach and is supporting weight of coach. Be sure to tighten clamp bolts on tie rod ends after toe-in adjustment is completed. Refer to "Toe-In Adjustment" in FRONT AXLE (SEC. 1) and make toe-in adjustment.

SPECIFICATIONS

MECHANICAL STEERING

STEERING GEAR

MAKE ..... Saginaw

TYPE ..... Recirculating Ball and Sector Nut

GEAR RATIO ..... 25.6 to 1

MODEL 572-D-1

WORM NUT
- Type ..... Ball
- Ball Diameter ..... 11/32″
- Number of Balls 84

BEARINGS
- Worm Thrust—Type ..... Tapered Roller
- Pitman Shaft Needle Housing
  - Width ..... 1.490″-1.500″
  - Inside Diameter ..... 1.7495″-1.7500″
  - Outside Diameter ..... 2.1245″-2.1255″
- Side Cover
  - Width ..... 0.990″-1.000″
  - Inside Diameter ..... 1.7495″-1.7500″
  - Outside Diameter ..... 2.1245″-2.1255″

ADJUSTMENTS
- Worm Bearings
  - Adjustment Type ..... Shims
  - Shim Sizes Available ..... 0.002″, 0.005″, 0.010″. & 0.030″
    NOTE: Use a Minimum of 3-0.002″ & 2-0.005″ Thick Shims
  - End Play in Worm ..... None
  - Pull at Wheel to Keep Wheel Moving ..... 1½ to 2 Lbs.
- Pitman Shaft Lash
  - Adjustment Type ..... Adjuster Screw
  - Pull Through Center (Includes Worm Bearing Load) ..... 2¾ to 3¼ Lbs.
- Back-up Adjuster ..... Screw in Until Stop Bottoms; Then Back Off ¼ Turn and Tighten Lock Nut

STEERING COLUMN AND BEVEL GEAR

STEERING BEVEL GEAR
- Ratio ..... 1.5 to 1
- Total Steering Ratio ..... 38.4 to 1
- Upper Bevel Pinion
  - Number of Teeth 18
- Lower Bevel Gear
  - Number of Teeth 27
- Backlash Between Gears
  - Theoretical ..... Min. 0.003″—Max. 0.005″

BEARINGS
- Steering Shaft—Upper
  - Type ..... Special Ball
  - Number of Balls 14

BEARINGS (Cont.)
- Steering Shaft—Lower
  - Type ..... Roller
  - Inside Diameter ..... 1.002″-1.007″
  - Outside Diameter ..... 1.542″-1.552″
  - Number of Rollers 30
  - Width ..... 0.0779″-0.0781″
- Bevel Gear Housing
  - Type ..... Needle
  - Inside Diameter ..... 1.0000″-0.9995″
  - Outside Diameter ..... 1.2495″-1.2505″
  - Width ..... 0.740″-0.750″
- Housing Cap
  - Type ..... Needle
  - Inside Diameter ..... 1.4995″-1.5000″
  - Outside Diameter ..... 1.8745″-1.8755″
  - Width ..... 0.990″-1.000″

ADJUSTMENTS
- Upper Bevel Pinion
  - Adjustment Type ..... Shims
  - Shim Thickness Available ..... 0.003″ & 0.010″
  - End Play ..... None
- Lower Bevel Gear
  - Adjustment Type ..... Adjuster Screw
  - End Play ..... None

SPRINGS
- Horn Cap
  - Free Length ..... 1.359″
  - Compressed Length Under 4 Lbs. ..... 0.234″
- Shaft Upper Bearing
  - Free Length ..... 1.0937″
  - Compressed Length Under 40-50 Lbs. ..... 0.8125″

STEERING DRAG LINK

TYPE ..... Adjustable Length

LENGTH—Stud Centers ..... 33.12″ + or − 5/32″

SPRINGS
- Stud Seat Spring
  - Free Length ..... 0.750″
  - Compressed Length Under 350-400 lbs. ..... 0.500″
- Socket Centering Spring
  - Free Length ..... 1.250″
  - Compressed Length Under 30 Lbs. ..... 0.875″

STEERING DRIVE SHAFT

Universal Joint (Slip Joint End) ..... 1281 Series

Universal Joint (Fixed Joint End) ..... 1288 Series

Journal Diameter ..... 0.5965″-0.5970″

Bearing Rollers—Quantity 23

Length—Centerline of Journal at One End to Centerline of Journal at Opposite End ..... 63½″

MECHANICAL STEERING SYSTEM SPECIFICATIONS (CONT.)

TORQUE SPECIFICATIONS

Location	Torque Foot-Pounds
Lash Adjuster Lock Nut	25-35
Side Cover Bolt	25-35
Drive Shaft Flange to Worm Shaft Nut	30-35
Drive Shaft Flange to Lower Gear Shaft Nut	30-35
Steering Wheel Nut	30-35
Top Cover Bolt	35-45
Back-up Adjuster Lock Nut	30-50
Drag Link End Socket Tube Clamp Bolt Nut	45-55
Steering Gear to Support Stud Lock Nut	45-55
Steering Gear Clip to Support Stud Lock Nut (TDH4516, TDH5301, and TDM5301)	90-110
Steering Gear Clip to Support Stud Lock Nut (TDH/TDM-4517, SDH/SDM-4501, SDH/SDM-5301, and TDH/TDM-5302)	150-180
Steering Gear to Front Axle Beam Bolt	170-180
Drive Shaft to Steering Gear U-bolt Lock Nuts	15-20
Drive Shaft to Bevel Gear Pinch Bolt Lock Nut	15-20
Steering Column Housing to Bracket Bolt	90-110
Steering Column Support Flange Bolt Lock Nut	10-15
Steering Column Support Flange and Floor Plate to Floor Bolt Nut	10-15
Drag Link to Steering Arm Nut	150 Lbs. Minimum and Advance to Nearest Cotter Key Hole
Pitman Arm to Drag Link Nut	150 Lbs. Minimum and Advance to Nearest Cotter Key Hole
Pitman Arm to Steering Gear Pitman Shaft Nut	250-300
Upper Cover to Bevel Gear Housing Bolt	25-30
Cap to Bevel Gear Housing Bolt	20-25
Pinion Gear to Steering Shaft Nut	40-50

Power Steering

The power steering system, available as special equipment on coaches covered in this manual, provides automatic hydraulic assistance to the turning effort applied to the mechanical steering system. The power steering is adaptable to the standard mechanical steering described previously with a minimum amount of alterations.

The power steering system consists primarily of three units, used in conjunction with the conventional steering gear:

1. Control Valve.
2. Booster Cylinder.
3. Hydraulic Pump.

NOTE: The steering gear assembly, used with the power units on early model coaches equipped with power steering, is basically the same as the steering gear assembly described earlier in this section under "MECHANICAL STEERING" system. The procedures for adjustment, replacement, and overhaul are the same except when making worm bearing adjustment, pull required to keep the worm in motion should be 6-3/4 to 9 inch-pounds. When making Pitman shaft lash adjustment, pull through center (includes worm bearing load) should be 16 inch-pounds maximum.

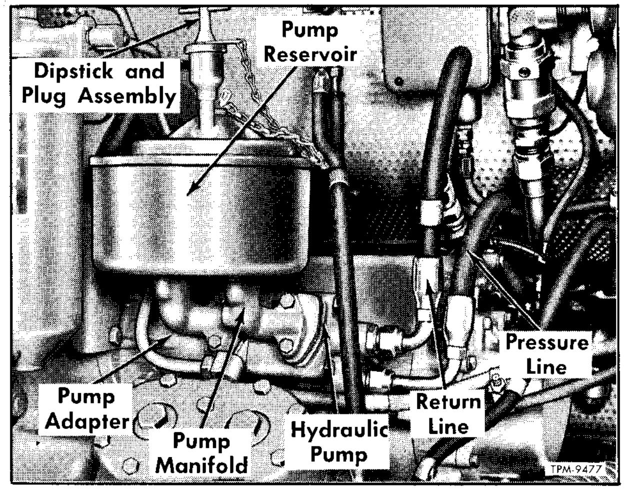
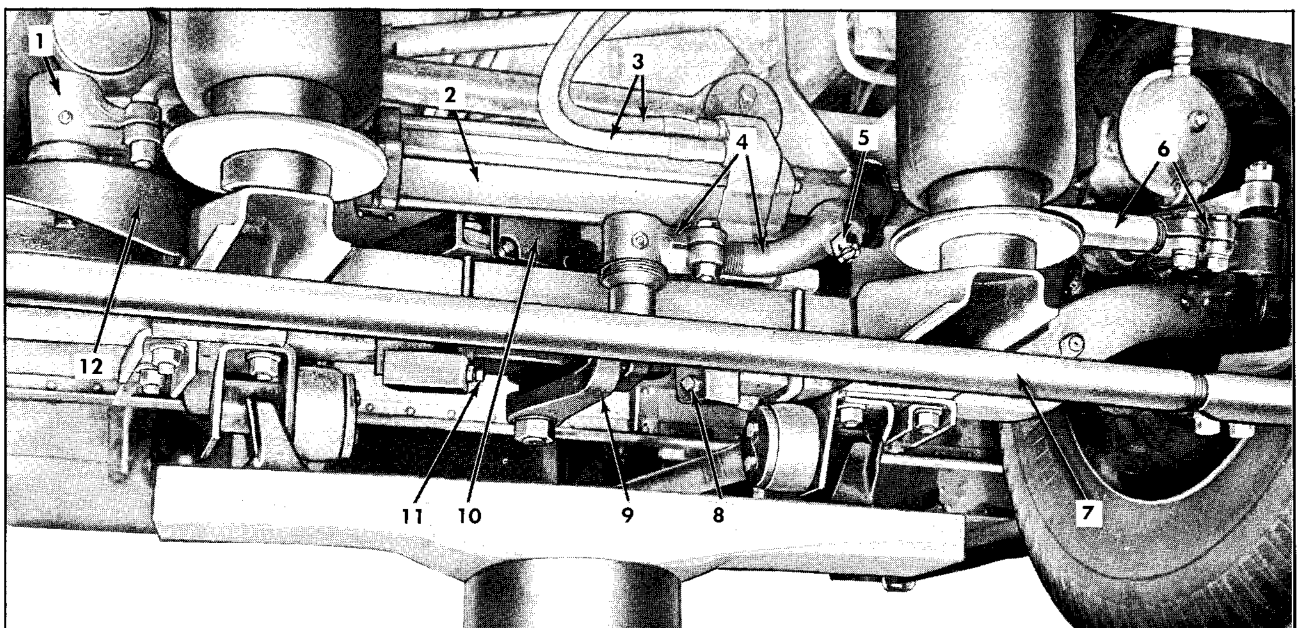


Figure 1—Power Steering Hydraulic Pump Installed

On late model coaches, the steering gear used with power steering is the same steering gear used with mechanical steering described earlier.



1 Piston Rod Socket End Assy.
2 Booster Cylinder Assy.
3 Pressure and Return Line Hoses
4 Drag Link Assy.
5 Booster Cylinder Ball Stud
6 Extension and End Socket Assy.
7 Steering Tie Rod
8 Pitman Arm Right-Hand Stop
9 Pitman Arm
10 Steering Gear Assy.
11 Pitman Arm Left-Hand Stop
12 Piston Rod Socket End Support

TPM-7215

Figure 2—Power Steering Booster Cylinder Installed

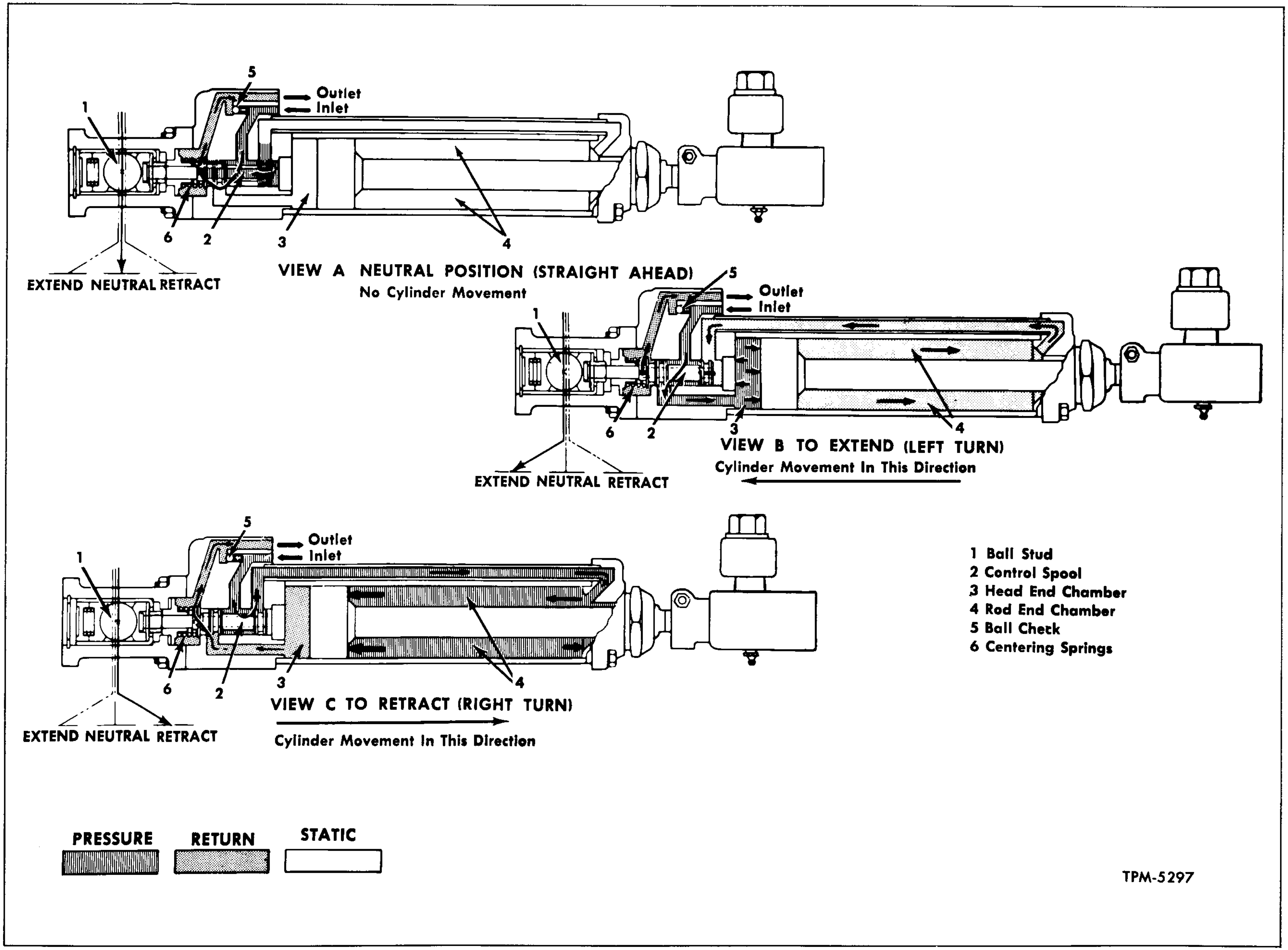


Figure 3—Operational Diagrams of Steering Booster Cylinder

OPERATION

Power steering is accomplished through use of hydraulic pressure. This pressure is supplied by a vane-type oil pump mounted at left rear of the engine. The pump is driven through a coupling by engine blower drive shaft (fig. 1). Pressure created by the pump is circulated through flexible fluid lines to a self-contained actuating booster cylinder installed on the front axle (fig. 2). Movement of steering wheel is transmitted through conventional Pitman arm and drag link to a control valve located in booster cylinder. This control valve directs hydraulic fluid, under pressure created by the hydraulic pump, to either side of a piston in the booster cylinder, producing movement of piston and attached drag link of the coach steering linkage. Force applied by booster cylinder to drag link is automatically the amount of thrust necessary for all steering requirements.

Figure 3 illustrates schematic views of booster operations: View "A" illustrates neutral position; View "B" - left turn position (cylinder extended), and View "C" - right turn position (cylinder retracted).

Key numbers in the following text refer to figure 3.

Movement of steering wheel in either direction is transmitted to the mechanical linked ball stud (1) which in turn imparts linear movement to control valve spool (2). Oil flow from the hydraulic pump is directed by valve spool movement either to the head end or rod end chambers (3 or 4) of the booster cylinder as shown in Views "B" and "C," causing the booster to extend or retract. This action causes a corresponding movement of the booster which will continue so long as the control valve spool is offset by continued turning of the steering wheel. As soon as the turning of the steering wheel is stopped the booster will again come to center (neutral) position (View "A") and stop. In the event of power failure, check valve ball (5) will unseat, allowing free flow of oil throughout the booster. This will allow the steering mechanism to be moved manually, either by the steering wheel or by external force applied to the vehicle wheels.

Strong valve centering springs (6) on the control valve spool (2) provide the driver the desired steering "feel."

MAINTENANCE

The power steering hydraulic system requires little maintenance. However, the system should be kept clean to insure maximum operating performance and trouble-free service. Periodic inspection to check for leaks should also be made.

At regular intervals the hydraulic fluid level in pump reservoir should be checked and fluid add-

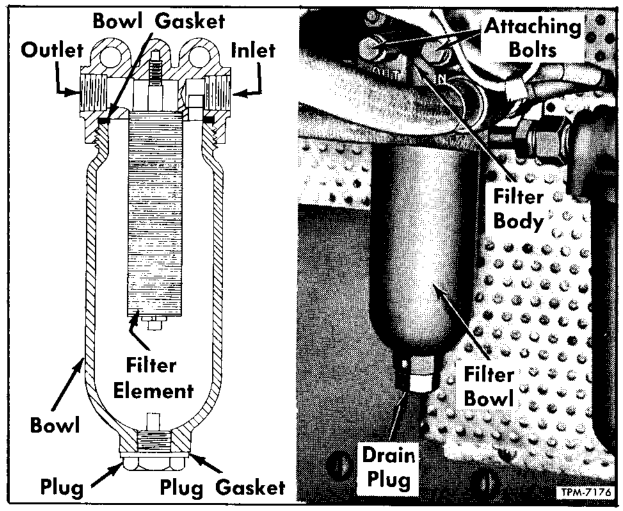


Figure 4—Fluid Filter Installed

ed when required. Refer to LUBRICATION (SEC. 13) of this manual for type fluid to be used, method, and intervals for filling. The fluid reservoir is mounted on the hydraulic pump. When the slightest evidence of dirt, sludge, or water is discovered in the system, drain and refill with clean recommended hydraulic fluid. Refer to LUBRICATION (SEC. 13) for procedures. To drain system, disconnect fluid lines at booster cylinder.

Power steering fluid filter located in fluid line at engine bulkhead (fig. 4) should be serviced at regular lubrication intervals. Refer to "Power Steering Fluid Filter" later in this section for servicing fluid filter.

Air in the fluid system will cause spongy action and noisy operation. When any hose has been disconnected or when fluid has been lost for any reason, the system must be bled after adding fluid. Bleed system as directed later in this section under "Bleeding Power Steering Hydraulic System." Should the power steering system become inoperative because of loss of hydraulic fluid, pump pressure line should be re-routed from pump outlet directly back to pump reservoir.

IMPORTANT: Do not operate pump without fluid in the pump reservoir.

If steering linkage between steering gear and front wheels is out of adjustment, bent, twisted, or worn, steering action of coach will be seriously affected. At any time steering linkage parts are repaired, replaced, or adjusted, steering geometry and front wheel alignment must be checked. Refer to FRONT AXLE (SEC. 1) of this manual for front end alignment information.

At regular lubrication intervals, the steering linkage should be checked completely for worn or loose ball stud end sockets.

If coach steering tends to wander in one direc-

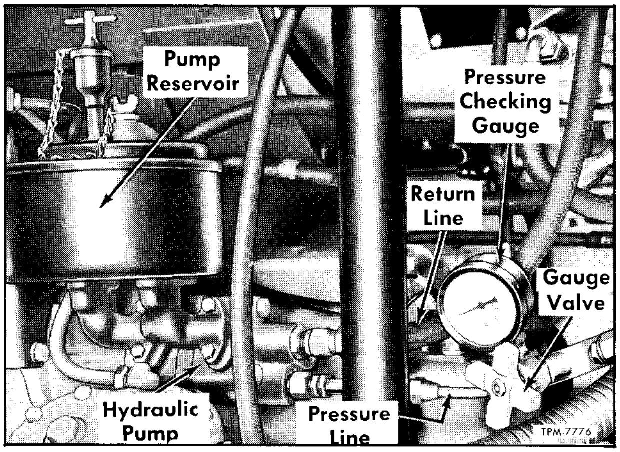


Figure 5—Checking Pump Hydraulic Pressure (Typical)

tion, after making certain that front end is properly aligned, cause may be that the control valve in booster cylinder may not be centering properly. Adjust control valve as explained later under "Control Valve Adjustment."

BLEEDING POWER STEERING HYDRAULIC SYSTEM

When power steering hydraulic pump, booster cylinder assembly, or fluid filter has been removed for overhaul or replacement, or any hydraulic system lines disconnected, the hydraulic system must be bled before vehicle is again operated. Bleed power steering hydraulic system as follows:

NOTE: When hydraulic fluid is added to power steering system, fluid should be poured through a 200 mesh wire screen secured inside funnel. Use only the hydraulic fluid recommended in LUBRICATION (SEC. 13) of this manual in the power steering hydraulic system.

1. Fill power steering pump reservoir tank to "FULL" mark on dipstick. Let hydraulic fluid remain undisturbed for about two or three minutes.
2. Raise front end of coach until front wheels are well off floor.
3. Eliminate air pockets in booster cylinder and hydraulic system by turning front wheels to right and left Pitman arm stops. Continue this procedure, while maintaining fluid level in pump reservoir tank to "FULL" mark on dipstick, until fluid in pump tank stops bubbling.
4. Start engine and run at idle for two or three minutes. Turn front wheels to right and left as before. DO NOT HIT WHEEL STOPS. Maintain fluid level in pump reservoir tank to "FULL" mark on dipstick. Check system lines and connections for leaks. Continue these procedures until fluid in pump reservoir tank is clear and free of bubbles.
5. Increase engine speed to approximately half throttle and run engine at this speed until all signs of air bubbles cease to exist in pump reservoir tank. Turn wheels to right and left as before. DO NOT HIT PITMAN ARM STOPS.
6. Lower coach to floor and turn wheels to right and left while rechecking for fluid leaks.
7. Recheck fluid level in pump reservoir tank and fill to "FULL" mark on dipstick.

HYDRAULIC PRESSURE TEST

1. Disconnect pressure hose from fitting at the hydraulic pump.

NOTE: Some hydraulic fluid will leak out when line is disconnected. Provision should be made to catch this fluid.

2. Connect 0 to 1000 psi pressure checking gauge (J-5631-01) (fig. 5) between the pump pressure port and pressure hose. Leave valve in pressure gauge open.
3. Bleed steering hydraulic system to remove all air from pressure line as directed previously under "Bleeding Hydraulic System."
4. Start engine and run at idle speed. Turn wheels through normal operating range several times until the hydraulic fluid temperature reaches 170°F. When fluid temperature reaches 170°F., close valve in pressure gauge line and observe reading on pressure gauge. Pressure reading should be 950 to 1050 psi.

IMPORTANT: Do not leave valve closed for more than 15 seconds.

5. Open valve in pressure gauge line. Turn wheels to extreme right and left against "stops" (with wheels on ground). At extreme right or left position the maximum pressure reading should be within the amount specified in procedure 4 above.
6. If pump pressure is less than amount specified, make necessary repairs described under "Hydraulic Pump Overhaul" later in this section.
7. If pump pressure is satisfactory, shut off the engine and remove pressure checking gauge.
8. Reconnect pressure hose to pump port fitting; then bleed hydraulic system as described previously under "Bleeding Power Steering Hydraulic System."

BOOSTER CYLINDER CONTROL VALVE ADJUSTMENT

Power steering booster cylinder is equipped with an adjustable control valve. At time of manufacture this valve is adjusted to provide straight ahead control, thus any tendency to wander to right or left can be corrected by proper adjustment of the control valve. Whenever the booster cylinder has been overhauled, or vehicle wanders to right or left, the following adjustment should be made.

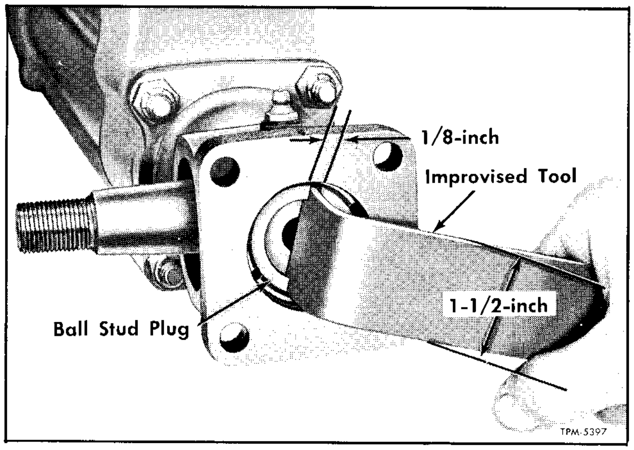


Figure 6—Removing Ball Stud End Plug With Improvised Tool

In some instances operators may perform this adjustment on a bench, using an auxiliary source for hydraulic pressure. When adjustment must be made on the vehicle the following instructions apply:

1. Disconnect booster cylinder assembly from adjustable extension by removing four attaching nuts and bolts.
2. At piston rod end socket ball stud, remove cotter pin and nut. Remove ball stud from suspension support bracket.
3. At booster cylinder ball stud body, remove snap ring, lock key, end plug, and spring. NOTE: Use improvised tool shown in figure 6 to remove end plug. Remove ball stud and two ball stud seats. Remove centering nut locking washer from centering nut. Straighten tab on locking washer if washer is to be reused.
4. Suspend booster cylinder assembly in a horizontal position so that piston rod can extend or retract without interference.
5. Start engine and run at fast idle (approximately 600 to 700 rpm) to operate power steering hydraulic pump. Insert a screwdriver in slot of spool as shown in figure 7. Hold the centering nut firmly in position, and adjust the spool until the rod is in 1/2 extended position. To do this turn the spool clockwise to retract or counterclockwise to extend the rod. The spool is centered when the rod does not creep in either direction.
6. Lock valve spool in place by installing centering nut locking washer. Insert inside diameter tabs of the locking washer in slot of spool. One of the outside diameter tabs should then line up with one of the centering nut slots. Bend tab of washer into slot of centering nut (fig. 8), using punch and hammer.
7. Install ball stud seat, ball stud, and second ball seat in body. Install ball stud seat spring; then thread end plug into body to secure ball stud and seats. Thread plug against the spring solidly; then back off to first key slot in ball stud sleeve. Install lock key and snap ring.
8. Recheck for piston rod creeping (Step 5 above); there must be no movement of rod. Repeat adjustment procedures if creeping of piston rod is apparent.
9. Position piston rod end socket ball stud in hole of suspension support bracket; then install stud nut, tightening securely. Install new cotter pin.
10. Align booster cylinder assembly with adjustable extension; then install four attaching bolts and lock nuts. Install new cotter pins.

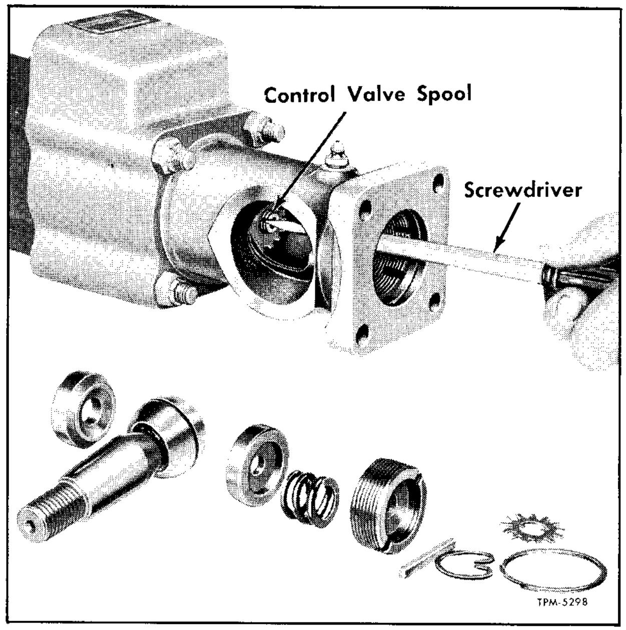


Figure 7—Adjusting Booster Cylinder Control Valve Spool

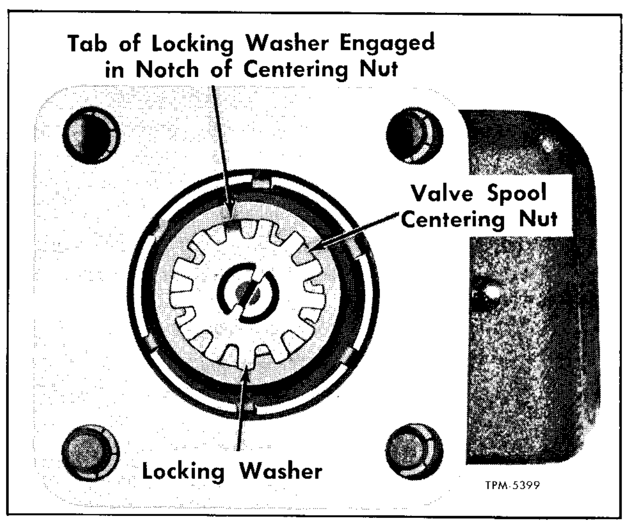


Figure 8—Valve Spool Locking Washer Installed

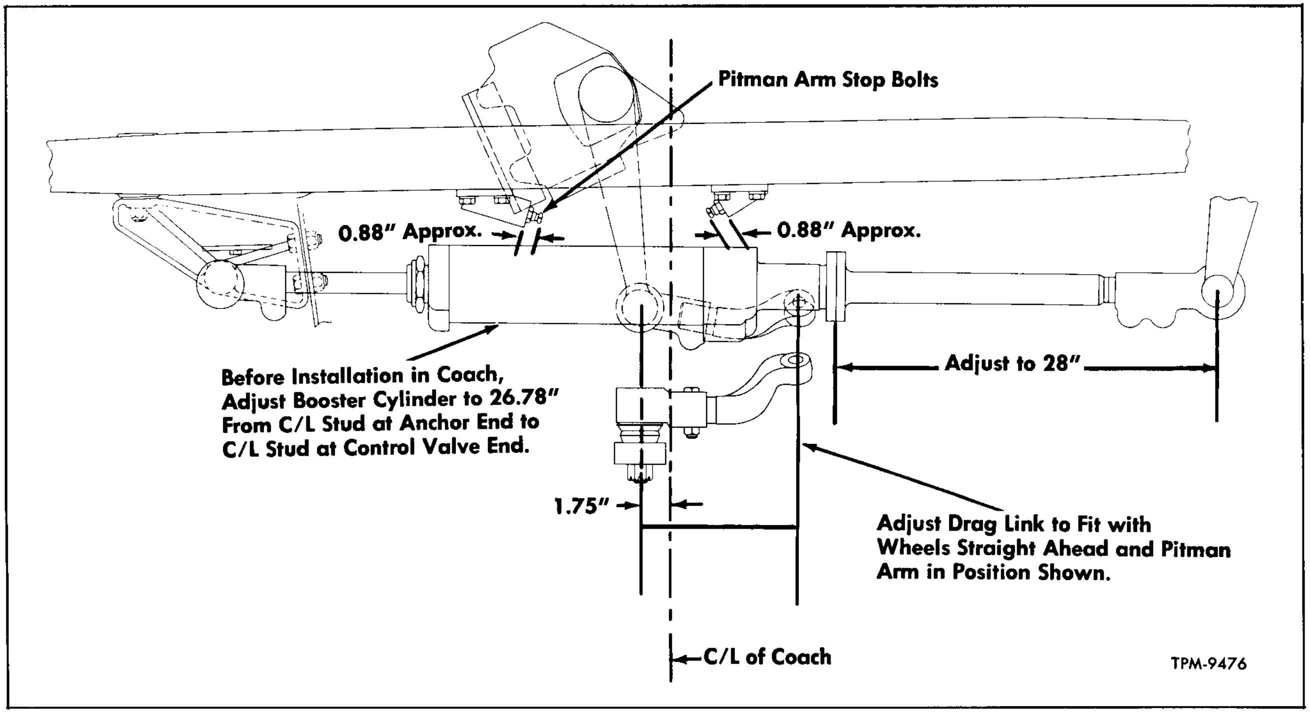


Figure 9—Power Steering Booster Cylinder Installation (TDH-4516, TDH-5301, and TDM-5301)

11. Lubricate end socket ball stud as directed in LUBRICATION (SEC. 13) of this manual.

12. Bleed power steering system as described earlier in this section under "Bleeding Power Steering Hydraulic System."

BOOSTER CYLINDER REPLACEMENT

Power steering booster cylinder assembly, installed as shown in figure 2, can be readily removed from coach at any time service is required that necessitates disassembly or partial disassembly of the unit. Remove booster cylinder assembly from coach as described in the following text: When reinstalling booster cylinder assembly, be sure to accomplish adjustment procedures previously outlined.

REMOVAL

1. Attach identification tags to flexible pressure and return hoses; then remove hoses and drain fluid from hoses and cylinder into a clean pan.

2. Remove cotter pin and stud nut attaching adjustable steering drag link to booster cylinder ball stud. Discard cotter pin.

3. Remove cotter pin and stud nut attaching piston rod end socket tapered stud to suspension support bracket. Discard cotter pin.

4. Remove four cotter pins, nuts, and bolts attaching flange of booster cylinder ball stud body to flange of adjustable extension.

5. Remove booster cylinder assembly from drag link end and suspension support bracket. It may be necessary to use a suitable puller to aid in removal.

6. Remove dust cover spring and dust cover from booster cylinder ball stud.

7. Remove dust cover spring, shield, dust cover, and washer from piston rod end socket tapered stud.

8. If necessary, remove set screw and clamp bolt; then turn piston rod end socket off piston rod.

INSTALLATION (Refer to Figs. 2, 9, and 10)

1. Before installing booster cylinder assembly in coach, compress booster cylinder into fully retracted position; then thread piston rod end socket assembly on booster cylinder piston rod to a dimension of 26-25/32", measured from centerline of socket end tapered stud to centerline of booster cylinder ball stud.

2. Position dust cover and dust cover spring on booster cylinder ball stud.

3. Position washer, dust cover, shield, and dust cover spring on piston rod end socket tapered stud.

4. Check length of cylinder extension and end socket assembly, measuring from center of end socket ball stud to flange of extension (figs. 9 and 10). Distance should measure 22" on TDH/TDM-4517, TDH/TDM-5302, SDH/SDM-4501, and SDH/

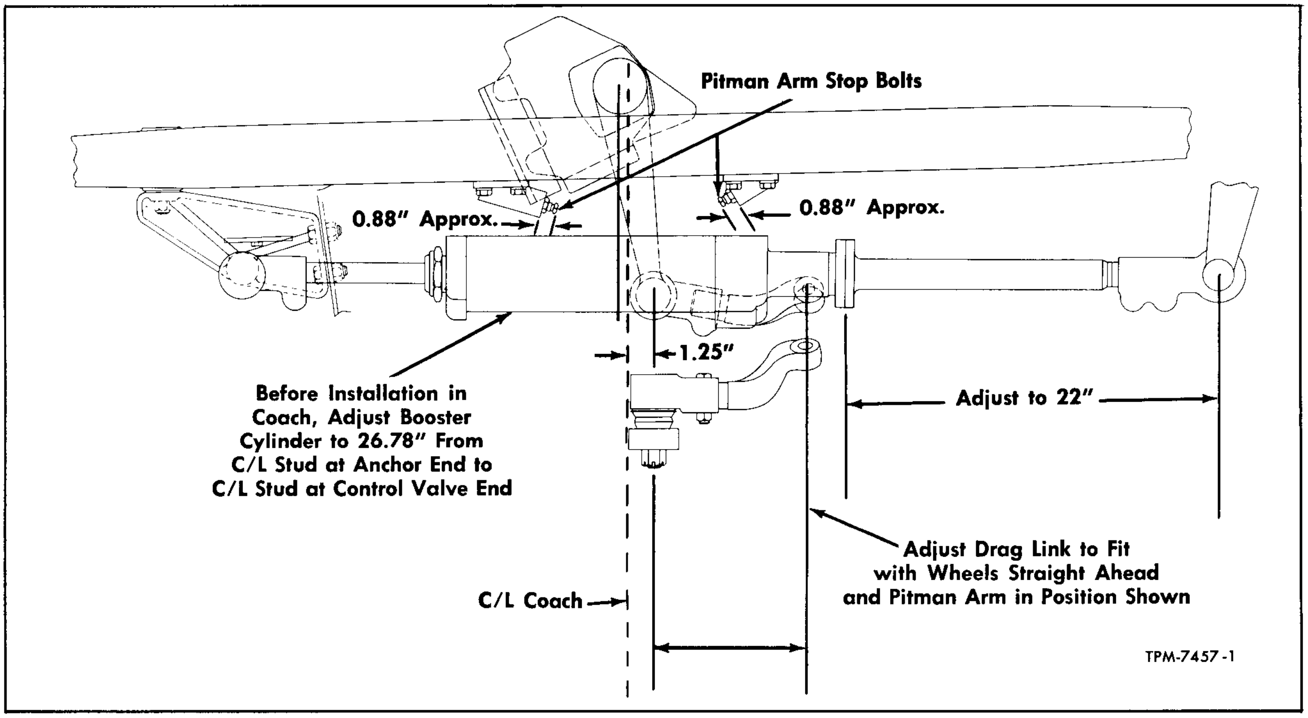


Figure 10—Power Steering Booster Cylinder Installation (TDH and TDM—4517, TDH and TDM-5302, SDH and SDM—4501, and SDH and SDM-5301)

SDM-5301 coaches. Distance should measure 28" on TDH-4516, TDH-5301, and TDM-5301 coaches. Adjust if necessary, to obtain these dimensions.

5. At this stage of installation the booster cylinder should be suspended horizontally under coach and fluid lines connected to unit; then the control valve should be adjusted for centering. See "Booster Cylinder Control Valve Adjustment" explained previously. Start with Step 3.

6. Position booster cylinder ball stud body flange to flange of end socket extension, at the same time inserting booster cylinder ball stud in hole at end of drag link and piston rod end socket tapered stud into hole in suspension support bracket. NOTE: Cylinder ball stud to drag link must be positioned at bottom of cylinder.

7. Dip threads of extension bolts in grease containing zinc oxide (#3); then attach booster cylinder ball stud body flange to flange of end socket extension with four bolts and lock nuts. Tighten bolts to 40-50 foot-pounds torque; then advance lock nuts to nearest cotter pin holes and install new cotter pins.

8. With booster cylinder ball stud inserted through hole at end of drag link, install stud nut on ball stud. Tighten stud nut to 150 foot-pounds torque; then advance nut to nearest cotter pin hole and install new cotter pin.

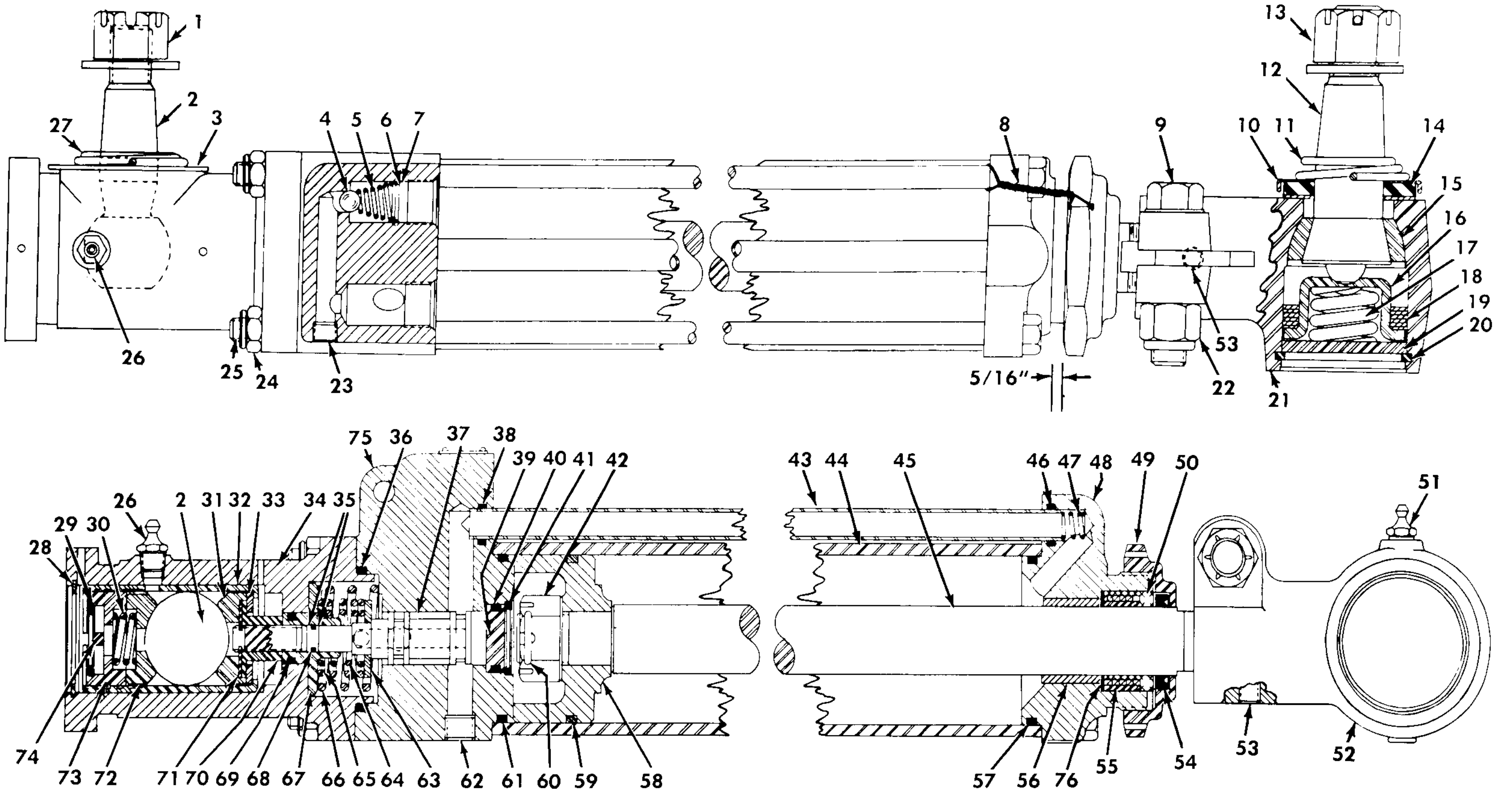
9. With piston rod end socket tapered stud inserted through hole in suspension support bracket, install stud nut on tapered stud. Tighten nut to 150 foot-pounds torque; then advance nut to nearest cotter pin hole and install new cotter pin to retain nut.

IMPORTANT: It is important that the following adjustments be checked.

10. Check position of Pitman arm as described previously under "Steering Gear Replacement" in "MECHANICAL STEERING." With front wheels and steering wheel in straight-ahead position, centerline of hole at drag link end of arm should be 1.75" to left of centerline of coach, when viewed from the rear, on TDH-4516 TDH-5301, and TDM-5301 coaches (fig. 9). On TDH/TDM-4517, TDH/TDM-5302, SDH/SDM-4501, and SDH/SDM-5301 coaches, centerline of hole at drag link end of Pitman arm should be 1.25" to the right of centerline of coach (fig. 10).

NOTE: Centerline of coach can be identified by prick punch marks on back of front axle beam.

11. If Pitman arm is incorrectly positioned, disconnect drag link from Pitman arm. Loosen clamp bolt securing end socket to drag link. With Pitman arm positioned as described in Step 10, and front wheels and steering wheel in straight-ahead position, turn end socket on drag link as required to align center of end stud with center of hole in Pitman arm. Attach end socket to Pitman arm. Tighten stud nut to 150 foot-pounds torque. Install new cotter pin.



1 Stud Nut
2 Ball Stud
3 Dust Cover
4 Check Valve Ball
5 Check Valve Ball Spring
6 Ball Spring Washer
7 Snap Ring
8 Lock Wire
9 Clamp Bolt
10 Dust Cover Shield
11 Dust Cover Spring
12 Tapered Stud
13 Stud Nut
14 Dust Cover
15 Stud Bearing
16 Stud Spring Seat
17 Stud Spring
18 Grease Retainer
19 Stud Spring Retainer
20 Snap Ring
21 Socket End
22 Lock Nut
23 1/8" Pipe Plug
24 Thru Bolt Nut
25 Thru Bolt
26 Lubrication Fitting
27 Dust Cover Spring
28 Snap Ring
29 Snap Ring
30 Ball Stud Seat Spring
31 Ball Stud Inner Seat
32 Ball Stud Sleeve
33 Valve Centering Nut Washer
34 Ball Stud Body
35 Back-up Washers
36 O-ring Seal
37 Valve Spool
38 Oil Passage Tube O-ring Seal
39 Valve Body Plug
40 O-ring Seal
41 Snap Ring
42 Piston Rod Nut
43 Oil Passage Tube
44 Cylinder Tube
45 Piston Rod
46 O-ring Seal
47 Oil Passage Tube Spring
48 Cylinder Cap
49 Piston Rod Packing Nut
50 Packing Outer Adapter
51 Lubrication Fitting
52 Piston Rod End Socket Assembly
53 Set Screw
54 Piston Rod Oil Seal
55 Packing
56 Piston Rod Bushing
57 O-ring Seal
58 Piston
59 Piston Ring
60 Cotter Pin
61 O-ring Seal
62 1/4" Pipe Plug
63 Valve Centering Spring Washer
64 Valve Centering Spring (Inner)
65 Valve Centering Spring (Center)
66 Valve Centering Spring (Outer)
67 Centering Spring Retainer
68 O-ring Seal
69 O-ring Seal
70 Valve Centering Nut
71 Valve Centering Nut Locking Washer
72 Ball Stud Outer Seat
73 Ball Stud Sleeve Plug
74 Sleeve Plug Lock Key
75 Valve Body
76 Packing Inner Adapter

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Figure 11—Power Steering Booster Cylinder Assembly

IMPORTANT: Booster cylinder end of drag link must be tilted to same plane as flange of booster cylinder ball stud body before clamp bolt at Pitman arm end socket is tightened. Rotate link if necessary; then tighten bolt to 100 foot-pounds torque.

12. Check adjustment and position of booster cylinder extension and socket end assembly. If socket end assembly and booster cylinder are installed and adjusted correctly, flange of extension and flange of booster cylinder ball stud body will be tipped heel down 3° or almost level. (See figure 2.)

13. With all parts correctly positioned and adjusted, and all bolts and nuts properly torqued, connect inlet and outlet flexible lines to fittings of booster cylinder. Tighten set screw firmly in piston rod end socket at suspension bracket. Stake screw in three places.

14. Refill power steering hydraulic system and bleed system as directed previously under "Bleeding Power Steering Hydraulic System."

BOOSTER CYLINDER OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 11.

NOTE: If ball stud body (34), valve body (75), cylinder tube (44), and cylinder cap (48) have not been scribed with alignment marks, use prick punch and mark these parts so they can be reassembled in same relative position.

1. Remove socket clamp bolt nut (22) and bolt (9); then remove set screw (53) from piston rod end socket (52).

2. While holding piston rod (45) with a 1" open end wrench, turn piston rod end socket (52) off piston rod (45).

NOTE: Overhaul piston rod end socket assembly as described later under "Booster Cylinder Extension and End Socket." These procedures will also apply to the piston rod end socket.

3. Remove four nuts (24); then remove four thru bolts (25) attaching cylinder tube and cap assembly to ball stud body assembly.

4. Using plastic hammer, tap valve body assembly off cylinder tube and cap assembly.

5. Remove oil passage tube (43) from bore in cylinder cap (48); then remove oil passage tube spring (47) from bore in cap.

6. Cut lock wire (8) from hole in piston rod packing nut (49); then turn packing nut off threads of cylinder cap.

7. Pull piston rod assembly out of cylinder tube and cap.

8. Remove one piston rod packing outer adapter (50), five piston rod chevron packings (55), and one piston rod packing inner adapter from cylinder cap. Discard packings.

9. Remove piston rod wiper seal (54) from piston rod packing nut (49). Discard wiper seal.

10. Separate cylinder tube (44) from cylinder cap (48). It may be necessary to tap on cap lightly with plastic hammer to separate units.

11. Remove cylinder cap O-ring seal (57) from cylinder cap (48). Discard seal.

12. Remove oil passage tube O-ring seal (46) from bore in cylinder cap (48). Discard seal.

13. Remove piston rod bushing (56) from bore in cylinder cap (48), only if inspection indicates necessity for removal.

14. Using fingers to spread ring, remove piston ring (59) from groove in piston (58). Do not spring ring more than necessary when removing from piston.

15. Remove piston rod nut cotter pin (60); then remove piston rod nut (42) and piston (58) from piston rod (45).

16. Remove oil passage tube O-ring seal (38) and valve body O-ring seal (61) from valve body (75). Discard both seals.

17. Using snap ring pliers, remove valve body plug snap ring (41) and valve body plug (39) from bore in valve body (75); then remove O-ring seal (40) from groove in plug. Discard seal. NOTE: It may be necessary to tap plug out of valve body with brass drift and hammer.

18. Using snap ring pliers, remove check valve ball spring snap ring (7); then remove washer (6), check valve ball spring (5), and check valve ball (4) from bore in valve body (75).

19. Remove valve body pipe plugs (23 and 62) from bores in valve body (75).

20. Remove valve outer centering spring (66) and valve body O-ring seal (36) from ball stud body (34). Discard seal.

21. Remove ball stud nut (1), dust cover spring (27), and ball stud dust cover (3) from ball stud (2). NOTE: If booster cylinder assembly was removed from coach just prior to disassembly procedures, these parts have been removed.

22. Using snap ring pliers, remove snap ring (28) and snap ring (29) from bore in ball stud body (34).

23. Remove lock key (74) from slots of ball stud plug (73) and ball stud sleeve (32).

24. Remove ball stud plug (73), ball stud spring (30), ball stud outer seat (72), ball stud (2), and ball stud inner seat (31) from ball stud body (34).

25. Remove locking washer (71) from end of spool stem; then turn centering nut (70) from stem by working screwdriver against lugs of nut. Remove flat washer (33) from spool stem.

26. Remove ball stud sleeve (32) from ball stud body (34).

27. Press valve spool (37) with attached springs, seals, and retainer as an assembly from ball stud body.

28. Remove valve centering spring retainer

(67), valve middle centering spring (65), inner valve centering spring (64), and valve centering spring washer (63) from stem of valve spool (37).

29. Remove valve centering spring retainer O-ring seal (69) from groove of valve centering spring retainer (67). Discard seal.

30. Remove valve spool O-ring seal (68) and back-up washers (35) from groove in valve spool (37). Discard seal and back-up washers.

31. Remove ball stud lubrication fitting (26) from bore in ball stud body (34).

CLEANING AND INSPECTION

Key numbers in text refer to figure 11.

1. Wash all parts thoroughly in cleaning solvent, making sure all accumulations of dirt, grease, or other foreign material is removed. Wipe parts dry with clean lint-free cloth, or blow parts dry with compressed air.

2. Inspect all oil passages in valve body (75), valve spool (37), and cylinder cap (48) to make sure they are clean. A piece of tag wire should be used to check for obstructions.

3. Inspect piston rod bushing (56) in cylinder cap for scoring or excessive wear. If bushing is damaged, remove from cap. Discard bushing.

4. Check cylinder tube (44) and oil passage tube (43) for dents or damage. Make sure inside of tubes are clean.

5. Examine all finished surfaces for nicks, scores, or pitting. Small nicks may be removed with crocus cloth. Replace all parts found to be damaged.

6. Inspect oil seal and ring grooves in valve spool (37), spring retainer (67), valve body (75), valve body plug (39), cylinder cap (48), and piston (58) making sure they are clean and not damaged.

7. Check all booster cylinder springs for free length, compressed length, distortion, or collapsed coils.

8. Check piston ring (59) for excessive wear or damage.

9. Check thru bolts (25) for distortion and threads on bolts for stripped or crossed condition.

10. Inspect all threaded components of cylinder for stripped or crossed condition.

ASSEMBLY

Key numbers in text refer to figure 11.

The following assembly procedures are arranged in a practical sequence for assembling power steering booster cylinder. It is assumed that all parts have been cleaned and inspected, or replaced, as deemed necessary and previously described.

When assembling booster cylinder use new seals, packings, cotter pins, and lock wire. Lubricate each moving part with clean hydraulic fluid recommended in LUBRICATION (SEC. 13) of this manual, before part is installed. When installing new O-ring seals, make sure seals are properly seated in their respective grooves to prevent pressure loss and air intake into hydraulic system.

1. Install ball stud lubrication fitting (26) (if removed) in bore of ball stud body (34). Tighten fitting securely.

2. Install new valve spool O-ring seal (68) and back-up washers (35), with rough side against O-ring seal in groove in valve spool stem (37). Use a sleeve or cover with stiff paper to avoid cutting O-ring seal during assembly. Make sure O-ring seal and back-up washers are properly seated in groove.

3. Install new valve centering spring retainer O-ring seal (69) in groove of spring retainer (67). Make sure seal is properly seated in groove.

4. Position valve centering spring washer (63), valve inner centering spring (64), valve middle centering spring (65), and valve centering spring retainer (67) over stem of valve spool (37).

5. Position valve spool assembly with springs in bore of ball stud body (34).

6. Insert ball stud sleeve (32) into ball stud body (34) and over spool stem.

7. Install flat washer (33) over spool stem, then thread spool centering nut (70) on spool stem (approx. 17 turns - leaving 3 full threads showing).

8. Position new valve body O-ring seal (36) and valve outer centering spring (66) over valve spool (37) and against ball stud body (34).

9. Install valve body pipe plugs (23 and 62) in bores of valve body (75). Tighten plugs securely.

10. Insert check valve ball (4), ball spring (5), and washer (6) in bore of valve body (75); then using snap ring pliers, install snap ring (7) to secure parts in place.

11. Install new O-ring seal (40) in groove of valve body plug (39), making sure seal is well seated in groove; then install plug with seal in bore of valve body (75).

12. Using snap ring pliers, install valve body plug snap ring (41) in groove of valve body (75).

13. Insert new valve body O-ring seal (61) and new oil passage tube O-ring seal (38) into grooves in valve body (75). Make sure both of these seals are well seated in their respective grooves.

14. Position piston (58) on piston rod (45); then install piston rod nut (42) on piston rod (45). Tighten nut firmly. Secure nut on piston rod with new cotter pin (60).

15. Using snap ring pliers to expand ring, install piston ring (59) in groove of piston (58). Do not expand ring more than enough to make the installation.

16. If piston rod bushing (56) was removed from cylinder cap (48) during inspection procedures, press new bushing into position in cylinder cap.

17. Position cylinder tube (44) in vise having soft jaw plates; then while carefully compressing piston oil ring (59) with fingers, install piston and rod assembly into cylinder tube (44).

18. Insert new oil passage tube O-ring seal (46) into bore in cylinder cap. Make sure seal is properly seated in groove.

19. Install new cylinder cap O-ring seal (57) into groove of cylinder cap (48), making sure seal ring is well seated into groove.

20. Position cylinder cap (48) over piston rod (45) and against cylinder tube (44), aligning alignment marks on cylinder cap with marks on cylinder tube.

21. Press new piston rod wiper seal (54) in piston rod packing nut (49). NOTE: Install seal with seal lip positioned as shown in figure 11.

22. Position one new piston rod packing inner adapter (76), five new piston rod chevron packings (55), and one piston rod packing outer adapter (50) over end of piston rod (45) and into cylinder cap (48).

IMPORTANT: Adapters and packings must be positioned as shown in figure 11.

23. Place piston rod packing nut (49) over end of piston rod and on cylinder cap (48). Tighten packing nut to dimension shown in figure 11. Install new lock wire (8) later. NOTE: Piston rod packing nut (49) should not be tightened excessively, as piston rod (45) and piston (58) should slide freely in cylinder tube (44) with hand pressure of approximately 35 pounds of force.

24. Insert oil passage tube spring (47) in bore of cylinder cap (48).

25. With aligning marks on valve body (75) aligned with marks on cylinder cap (48) and cylinder tube (44), move valve body against cylinder tube, at the same time inserting oil passage tube (43) into bore of valve body (75), and bore in cylinder cap (48) against oil passage tube spring (47).

26. Place ball stud body (34) and parts against valve body (75), aligning marks on ball stud body with marks on valve body. Make certain aligning marks on ball stud body (34), valve body (75), cylinder tube (44), and cylinder cap (48) are in alignment; then install four thru bolts (25), and four thru bolt nuts (24) connecting the assembly. Tighten nuts on bolts alternately and evenly until assembly is securely held together. Torque nuts to 20 to 25 foot-pounds.

27. Install new lock wire (8) around one thru bolt and through hole in packing nut as shown in figure 11.

28. While holding piston rod (45) with a 1-inch open end wrench, turn piston rod end socket (52) on piston rod (45) and adjust for length as described later under "Booster Cylinder Piston Rod End Socket."

29. At this stage of assembly, cylinder control valve should be adjusted. Suspend cylinder assembly horizontally under coach; then connect fluid lines to unit. Proceed with Step 4 under "Control Valve Adjustment" explained previously to adjust valve and to complete assembly of cylinder. If valve is not to be adjusted at this time, continue assembly procedures outlined below:

30. Install ball stud inner seat (31), ball stud (2), ball stud outer seat (72), ball stud spring (30), and ball stud plug (73) in ball stud sleeve (32). Tighten plug (73) against spring solidly; then back off to first key slot in ball stud sleeve.

31. Position ball stud plug lock key (74) through slots in ball stud plug (73) and ball stud sleeve (32); then install snap ring (29) in groove of ball stud plug (73) to hold lock key (74) in place.

32. Using snap ring pliers, install snap ring (28) in groove of ball stud body (34).

33. If steering booster cylinder assembly is not to be installed on coach immediately after overhaul procedures have been completed, install drag link dust cover (3), dust cover spring (27), and stud nut (1) on ball stud (2), so these parts will not become lost before cylinder is to be installed.

BOOSTER CYLINDER EXTENSION AND END SOCKET

The booster cylinder extension assembly is two-piece type, composed of an extension and an end socket assembly. Extension is flanged at end which attaches to booster cylinder and threaded at opposite end for attachment of end socket assembly.

End socket stud is held against a tapered bearing by a seat and spring. An end plug and snap ring hold these parts in their correct relative position in end socket (fig. 12).

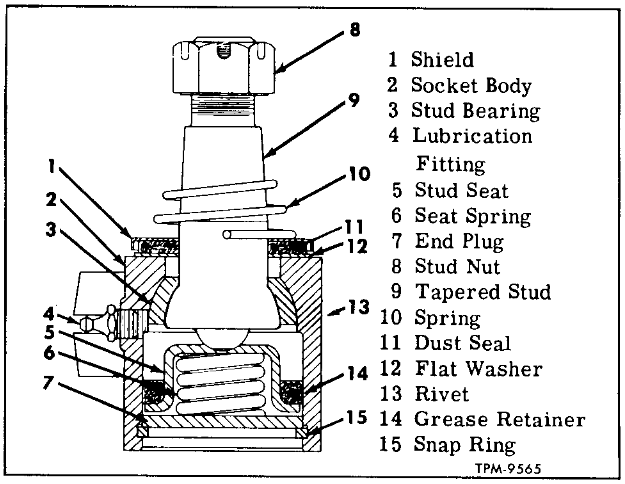


Figure 12—Booster Cylinder Extension End Socket

POWER STEERING

MAINTENANCE

Tapered stud nut must be kept tight, as any looseness of stud at steering arm will cause hole in arm to become enlarged and result in premature replacement of parts. Tightening stud nut after wear has occurred will result in damage to dust covers and springs, particularly when turning to extreme right and left.

Normal wear on bearing surfaces in end socket will cause increase in overall height of assembly. If excessive play is noted, it is evident that worn parts or complete end socket assembly must be replaced.

At intervals indicated, apply recommended lubricant as directed in LUBRICATION (SEC. 13) of this manual.

BOOSTER CYLINDER EXTENSION AND END SOCKET REPLACEMENT

REMOVAL

1. Remove cotter pin and nut attaching tapered end socket stud to right-hand steering arm. Strike steering arm a sharp blow with hammer as downward pressure is applied at end socket to remove stud from arm.
2. Remove four cotter pins, nuts, and bolts attaching extension to booster cylinder assembly. Discard cotter pins.

INSTALLATION

1. With the two clamp bolts loose, turn end socket onto extension until dimension from centerline of tapered stud to face of extension is 22" on TDH/TDM-4517, TDH/TDM-5302, SDH/SDM-4501, and SDH/SDM-5301 coaches. Distance should measure 28" on TDH-4516, TDH-5301, and TDM-5301 coaches. Do not tighten bolts until installation is complete.
2. Attach extension flange to booster cylinder flange using four bolts and nuts. Tighten nuts securely; then install new cotter pins to secure nuts.
3. Position dust cover washer, dust seal, dust cover seal, and spring over end socket tapered stud. Attach tapered stud to steering arm with nut and new cotter pin. Tighten end socket clamp bolts to 100 foot-pounds torque.

BOOSTER CYLINDER EXTENSION AND END SOCKET OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 12.

1. Remove extension and end socket assembly as previously instructed. Loosen two clamp bolts and nuts; then thread end socket assembly off extension.

NOTE: If end socket body is not being repaired or replaced, there is not need for removal from extension.

2. Remove shield spring (10), dust cover shield (1), dust seal (11), and dust cover washer (12) from tapered stud (9).
3. Remove snap ring (15), end plug (7), seat spring (6), stud seat (5), and grease retainer (14). When these parts are removed, tapered stud (9) and bearing (3) can easily be removed from end socket.

CLEANING AND INSPECTION

Immerse all parts in suitable cleaning solution to loosen and remove all accumulated dirt and grease. Use stiff bristle brush and repeat immersions until all parts are clean.

Inspect all parts for evidence of excessive wear or corrosion. Inspect springs for loss of tension and broken coils. Discard seal and grease retainer. Replace defective and excessively worn parts wherever necessary.

ASSEMBLY

Key numbers in text refer to figure 12.

1. During assembly procedures, lubricate parts with lubricant recommended in LUBRICATION (SEC. 13) of this manual.
2. Install bearing (3) into end socket with slot over rivet head. Install tapered stud (9).
3. In the order listed, install the following parts into end socket; grease retainer (14), stud seat (5), seat spring (6), end plug (7), and snap ring (15).
4. If removed, install lubrication fitting and fill with recommended lubricant.
5. Position dust cover washer (12), dust seal (11), dust cover shield (1), and shield spring (10) on tapered stud (9); then until ready to install the assembly on coach, install stud nut (8) to retain parts.
6. If socket end assembly was removed from extension, thread end socket on extension to a dimension of 22" on TDH/TDM-4517, TDH/TDM-5302, SDH/SDM-4501, and SDH/SDM-5301 coaches. Distance should measure 28" on TDH-4516, TDH-5301, and TDM-5301 coaches. Dimension is measured from centerline of tapered stud to face of extension (figs. 9 and 10).

BOOSTER CYLINDER PISTON ROD END SOCKET

Power steering booster cylinder piston rod end socket is of the same construction as booster cylinder extension end socket (fig. 12). Piston rod end socket threads directly on piston rod installed in booster cylinder assembly. Refer to "Booster Cylinder Extension and End Socket" described earlier in this section for overhaul procedures.

BOOSTER CYLINDER PISTON ROD END SOCKET REPLACEMENT

REMOVAL

1. Remove cotter pin and stud nut attaching piston rod end socket stud to suspension support bracket. Using a puller, force socket stud from bracket.
2. Remove set screw, then loosen socket end clamp bolt. Thread socket end assembly off piston rod.
3. Procedures required to overhaul booster cylinder piston rod end socket are the same as described previously under "Booster Cylinder Extension and End Socket."

INSTALLATION

1. Compress booster cylinder assembly into fully retracted position; then thread booster cylinder piston rod end socket on piston rod to a dimension of 26-25/32" measured from centerline of end socket tapered stud to centerline of booster cylinder ball stud.

2. When booster cylinder is correctly adjusted, install set screw and clamp bolt. Tighten clamp bolt to 100 foot-pounds torque. Stake set screw in three places.

3. Reinstall piston rod end socket to suspension support bracket. Tighten stud nut to 150 foot-pounds torque. Secure nut with new cotter pin.

POWER STEERING DRAG LINK

Adjustable steering drag link assembly used with power steering is composed of two parts, drag link and end socket assembly (fig. 13). Drag link end socket assembly is roller-bearing type incorporating adjustable features which automatically compensates for normal wear. End socket assembly at Pitman arm end of drag link assembly threads on drag link and provides for length adjustment. End socket assembly is secured to drag link by two clamp bolts, nuts, and lock washers. Opposite end of drag link engages booster cylinder ball stud and is secured by a stud nut and cotter pin.

MAINTENANCE

If steering linkage between the steering gear and front axle is out of adjustment, bent, twisted, or worn, steering action of coach will be seriously affected. At any time steering linkage parts are repaired, replaced, or adjusted, steering geometry and front wheel alignment must be checked. Refer to FRONT AXLE (SEC. 1) of this manual for procedures.

Stud nuts at socket end and booster cylinder ball stud end of drag link must be kept tight or hole at ball stud end of drag link and hole in Pitman arm may become enlarged as a result of excessive looseness. Subsequent tightening of stud nuts may draw studs into holes so far that dust cover parts may become damaged and result in premature replacement.

Drag link end socket is equipped with lubrication fittings and should be lubricated at regular intervals as directed in LUBRICATION (SEC. 13) of this manual.

DRAG LINK ADJUSTMENT

Drag link is adjusted properly when steering wheel is centered an equal number of turns between extreme right or left position, and the front wheels are positioned straight-ahead. In this position the centerline of hole at drag link end of the Pitman arm will be 1.75" to the left of centerline of coach when viewed from rear of front axle (fig. 9) on TDH-4516, TDH-5301, and TDM-5301 coaches. On TDH/TDM-4517, TDH/TDM-5302, SDH/SDM-4501, and SDH/SDM-5301 coaches, centerline of hole at drag link end of Pitman arm will be 1.25" to the right of centerline of coach (fig. 10). NOTE: Centerline of coach can be identified by prick punch marks on back of front axle beam.

1. If drag link needs adjustment, disconnect drag link at Pitman arm.
2. Loosen clamp bolts securing end socket to drag link. With Pitman arm positioned to dimension stated above (figs. 9 and 10), and front wheels straight ahead, turn end socket on drag link as required to align center of end stud with center of hole in Pitman arm. Attach end socket to Pitman arm. Tighten stud nut to 150 foot-pounds torque; then install new cotter pin.

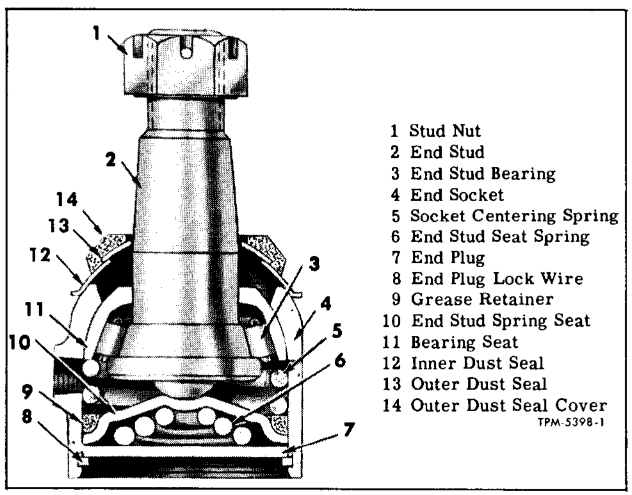


Figure 13—Power Steering Drag Link End Socket

POWER STEERING

IMPORTANT: Booster cylinder end of drag link must be tilted to same plane as flange of booster cylinder ball stud body before clamp bolt at Pitman arm end socket is tightened. Rotate link if necessary; then tighten clamp bolt to 100 foot-pounds torque.

DRAG LINK END SOCKET REPLACEMENT

Refer to "Steering Drag Link Adjustment" preceding for preliminary procedures which will apply for replacement of drag link end socket. In addition to adjustment procedures, remove end socket from drag link.

DRAG LINK END SOCKET OVERHAUL

DISASSEMBLY

Key numbers in text refer to figure 13.

1. Remove outer dust seal cover (14), outer dust seal (13), and inner dust seal (12) from end socket tapered stud.
2. Position end socket assembly in vise and press end plug (7) in against spring pressure far enough to remove end plug lock wire (8), by using a screwdriver to pry lock wire out of groove in end socket (4).
3. Remove end plug (7), end stud seat spring (6), end stud spring seat (10), grease retainer (9), socket centering spring (5), tapered end stud (2), end stud bearing (3), and end stud bearing seat (11) from drag link socket end (4).

CLEANING AND INSPECTION

Key numbers in text refer to figure 13.

1. Clean all parts except outer dust seal cover (14) thoroughly in cleaning solvent. Wipe or blow parts dry.
2. Inspect all parts for corrosion and excessive wear. Discard all parts not in good condition.
3. Check socket centering spring (5) and end stud seat spring (6) for free length, compressed length, distortion, or collapsed coils.
4. Inspect bearing rollers in end stud bearing assembly (3) for roughness or flaking. If rollers will not rotate freely in retainer, replace bearing assembly.
5. Discard dust seals, dust cover, and grease retainer.

ASSEMBLY

Key numbers in text refer to figure 13.

When assembling adjustable drag link end socket assembly, be sure all parts and working area are thoroughly clean. If dirt or foreign matter is allowed to get into drag link end socket assembly, excessive wear and premature replacement of parts will be the result. Lubricate each part with lubricant specified in LUBRICATION (SEC. 13) of this manual as part is installed.

1. Position end stud bearing seat (11) and stud bearing (3) on tapered end stud.
2. Insert stud and bearing assembly into drag link end socket (4).
3. Position socket centering spring (5) in end socket (4) against end stud bearing seat (11).
4. Press new grease retainer (9) over end stud spring seat (10); then position retainer and seat in end socket (4).
5. Install end stud seat spring (6), and end plug (7) in end socket (4).
6. With end socket assembly positioned in vise, apply pressure against end plug to compress springs; then install end plug lock wire (8) in groove of end socket (4).
7. Position inner dust seal (12), outer dust seal (13), and outer dust seal cover (14) over threaded end of tapered end stud.
8. With drag link end socket assembly cleaned, inspected, and repaired, assemble to drag link and adjust as directed previously under "Drag Link Adjustment."

POWER STEERING HYDRAULIC PUMP

The power steering pump (fig. 18) is a vane type, self-contained hydraulic unit which supplies hydraulic power for operation of the steering booster cylinder at front axle. Pump is mounted at rear of engine (fig. 1), and is driven by the blower drive shaft through a coupling (fig. 17).

OPERATION

Hydraulic fluid from pump reservoir enters pump body and is picked up by rotor vanes through inlet ports and pockets, then discharged under pressure through outlet ports in pump pressure plate. Fluid under pressure is also directed through another passage in pressure plate so it enters behind rotor vanes, forcing vanes to follow eccentric contour of rotor ring. Remainder of fluid is directed through an orifice in pressure outlet.

Orifice in pressure outlet is calibrated so pump output in excess of 4.0 gallons per minute will cause back pressure. This back pressure opens flow control valve against spring pressure, allowing excess fluid to return to pump reservoir.

If pressure in control valve reaches 950-1000 psi maximum pressure, relief valve will open against spring pressure to limit maximum fluid pressure. When pressure relief valve opens, it allows fluid in pressure outlet passage to pass

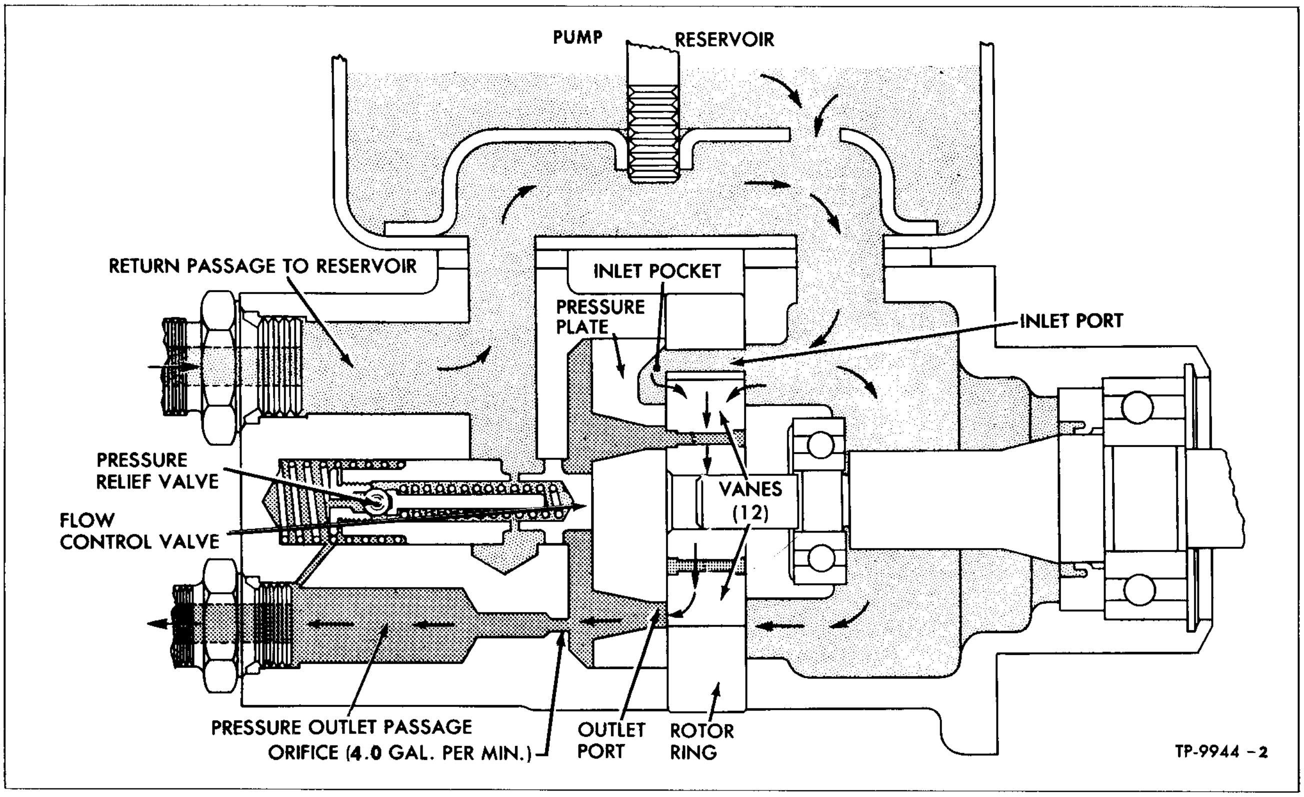


Figure 14—Fluid Flow In Pump With Low Vehicle Speed and Partial Turn (Typical)

through flow control valve into pump reservoir.

Fluid flow, as shown in figure 14, is typical of pump operation when coach is driven at low speed during a partial turn. Fluid pressure cannot become high enough to open relief valve, because the valve spool in control valve is still partially open, allowing some fluid to return to pump reservoir. Also, due to low pump speed, fluid pressure is not great enough to open flow control valve.

Figure 15 typically shows operation of steering pump flow control valve and pressure relief valve when coach is driven in full turn at low speed. In this instance, maximum pump pressure is being applied to booster piston to assist in turn and valve spool stops flow of fluid to pump reservoir. High fluid pressure that develops, opens both flow control valve and pressure relief valve which limits pressure by allowing the fluid to return to pump reservoir.

Figure 16 is a typical illustration of operation of flow control valve when coach is driven at high speeds. Pump output exceeds 4.0 gallons per minute, which opens flow control valve allowing fluid to return to pump reservoir. When operating coach at high rate of speed on straight-ahead driving or partial turns, valve spool in control valve is open also allowing fluid to return to pump reservoir. As long as valve spool remains open, pressure build-up will not be sufficient to open pressure relief valve.

HYDRAULIC PUMP REPLACEMENT

REMOVAL

Key numbers in text refer to figure 17.

1. Place a clean pan under power steering

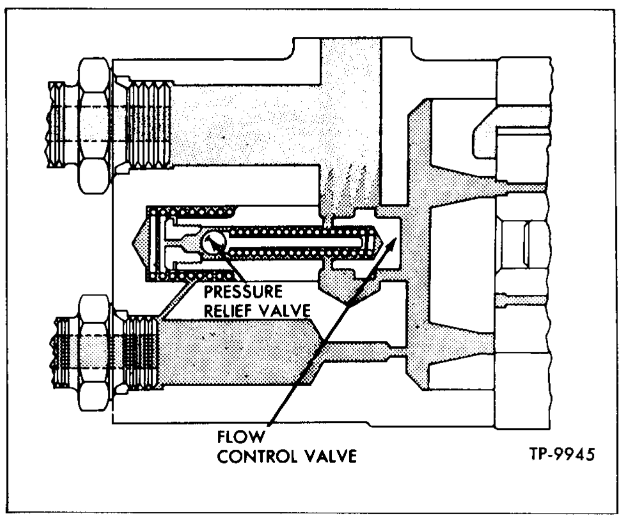


Figure 15—Flow Control Valve and Pressure Relief Valve Operation At Low Speed In Full Turn (Typical)

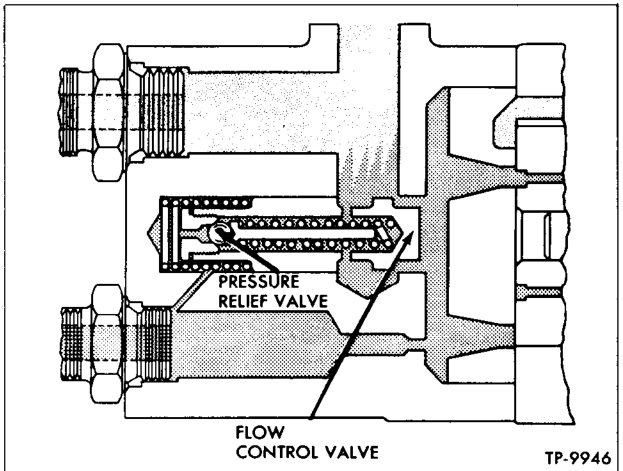
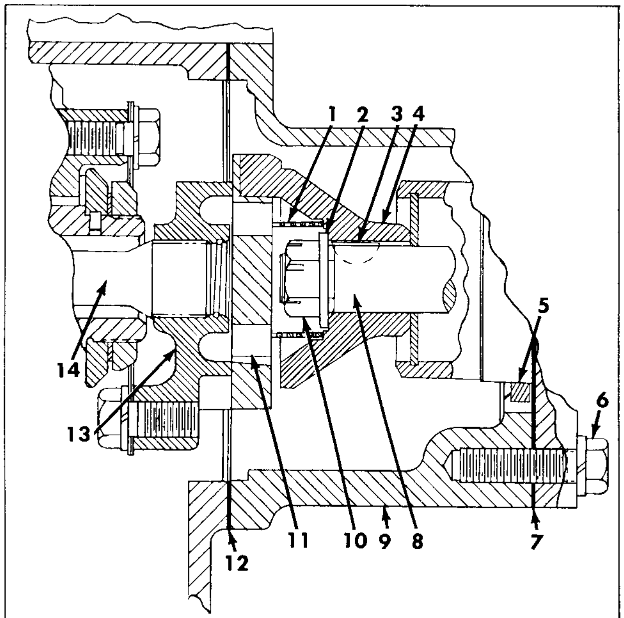


Figure 16—Flow Control Valve Operation At High Vehicle Speed (Typical)

pump pressure and return flexible lines and pump parts to catch hydraulic fluid; then remove lines from pump by unscrewing fittings.

2. Remove bolts, nuts, and lock washers attaching power steering pump and adapter assembly



1 Coupling Spring	7 Gasket
2 Plain Washer	8 Pump Drive Shaft
3 Driven Hub Key	9 Adapter
4 Power Steering Pump Driven Hub	10 Nut
	11 Pump Drive Coupling
5 Pump to Adapter Pilot Ring	12 Gasket
	13 Driving Hub
6 Pump to Adapter Attaching Bolt	14 Blower Drive Shaft

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Figure 17—Power Steering Pump Drive

to engine flywheel housing.

3. Using care to avoid dropping coupling ring (11) and coupling spring (1), remove pump and adapter assembly from engine.

4. Remove coupling ring (11) and coupling spring (1); then remove adapter to housing gasket (12). Discard gasket.

5. Remove lock nut (10) and plain washer (2) attaching driven hub (4) to pump drive shaft (8).

6. Remove two bolts (6) and lock washers attaching pump to adapter.

7. Remove adapter (9), adapter pilot ring (5), and gasket (7) from pump. Discard gasket.

INSTALLATION

1. If previously removed, install Woodruff key (3) in slot of pump drive shaft (8).

2. Position pump driven hub (4) on pump drive shaft (8), aligning Woodruff key in drive shaft with slot in hub (4).

3. Install lock nut (10) and plain washer (2) attaching pump driven hub (4) to pump drive shaft (8). Tighten nut to 55 foot-pounds torque.

4. Position adapter pilot ring (5) in the adapter (9); then attach adapter and new gasket (7) to power steering pump with two bolts and washers.

5. Install coupling spring (1) and coupling ring (11) in pump adapter, engaging prongs of driven hub (4) with slots in coupling ring (11).

6. Using new adapter to flywheel housing gasket (12), position pump and adapter assembly to flywheel housing, engaging prongs of driving hub (13) with slots in coupling ring (11).

7. Install adapter to flywheel housing attaching with bolts, nuts, and lock washers. Tighten securely.

8. Connect power steering pump pressure and return flexible lines to pump. Tighten fittings firmly

9. Refill power steering hydraulic system and bleed system as described previously under "Bleeding Power Steering Hydraulic System."

HYDRAULIC PUMP OVERHAUL

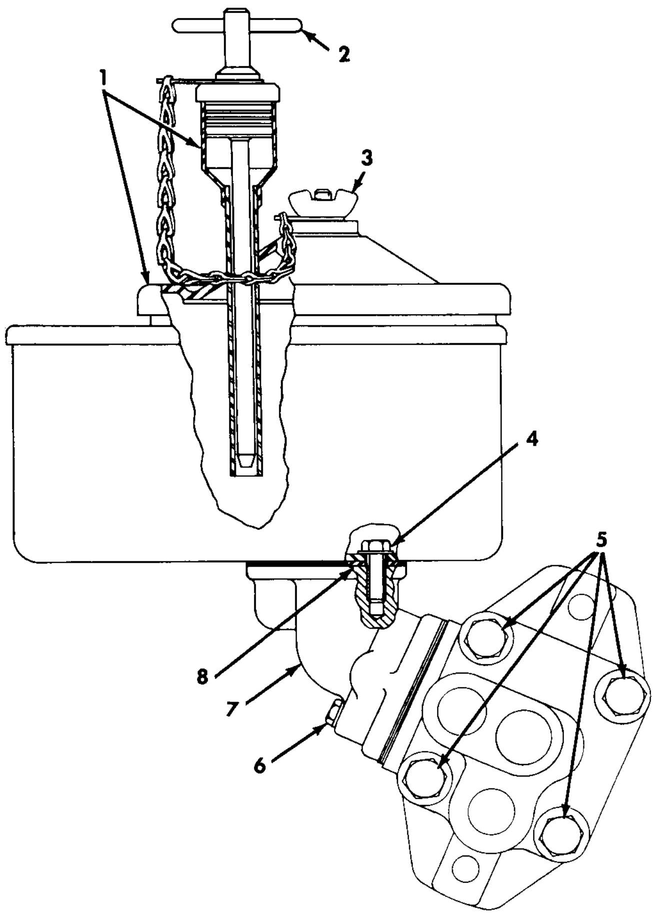
Overhaul of power steering hydraulic pump must be undertaken in clean working area with pump removed from coach engine. It is important that overhaul procedures described in the following text be carefully followed.

DISASSEMBLY

Key numbers in text refer to figure 18.

1. Using a suitable cleaning solvent, thoroughly clean the exterior of the hydraulic pump to prevent entry of dirt or other foreign matter into the pump during overhaul procedures.

2. Remove wing nut (3); then remove dipstick and plug assembly (2) from pump reservoir cover (1).



1 Cover and Tube Assembly
2 Dipstick and Plug Assembly
3 Cover Bolt Wing Nut
4 Reservoir to Manifold Attaching Bolt
5 Pump Cover to Body Attaching Bolts
6 Manifold to Pump Attaching Bolt
7 Pump Manifold
8 Gasket Spacer
9 Reservoir Cover Bolt Washer
10 Gasket
11 Cover Bolt Guide
12 Reservoir Cover Bolt
13 Cover Gasket
14 Reservoir Tank
15 Manifold to Reservoir Discharge Gasket
16 Manifold to Pump Discharge Gasket
17 Rotor Vane
18 Rotor and Drive Shaft Inner Bearing
19 Woodruff Key
20 Pump Drive Shaft
21 Snap Ring
22 Rotor and Drive Shaft Outer Bearing
23 Drive Shaft Oil Seal
24 Pump Body
25 Locating Pin
26 Pump Ring
27 Rotor
28 Flow Control Valve
29 Flow Control Valve Spring
30 O-ring Seal
31 Flow Control Spring Plug
32 Snap Ring
33 Pump Cover
34 Manifold to Pump Return Gasket
35 Pressure Plate
36 O-ring Seals
37 Manifold to Reservoir Return Gasket
38 Cover Plate
39 Oil Baffle

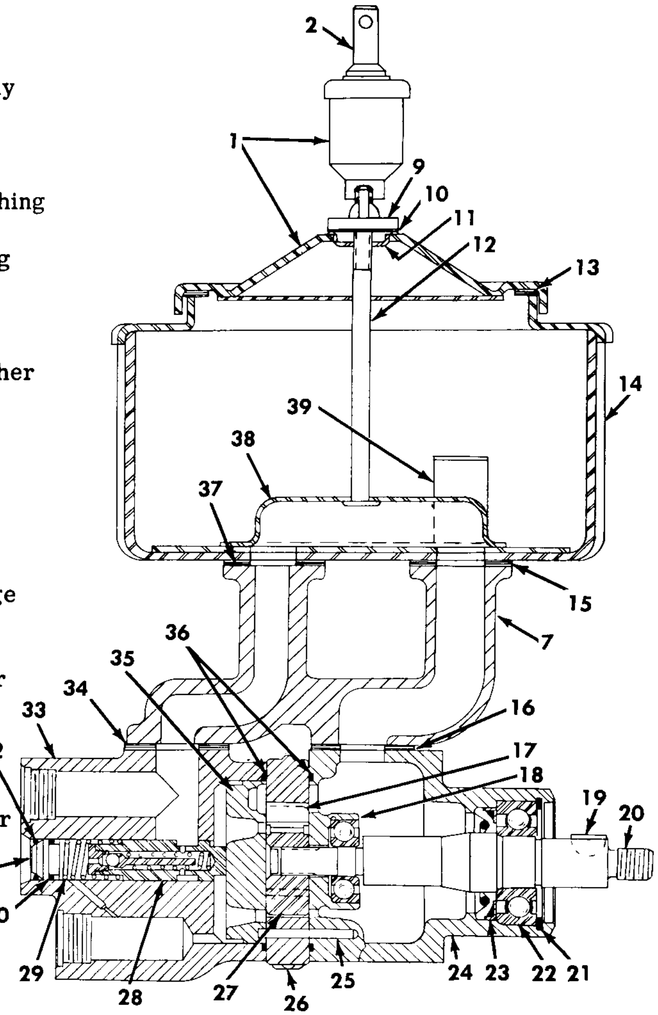


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Figure 18—Power Steering Hydraulic Pump

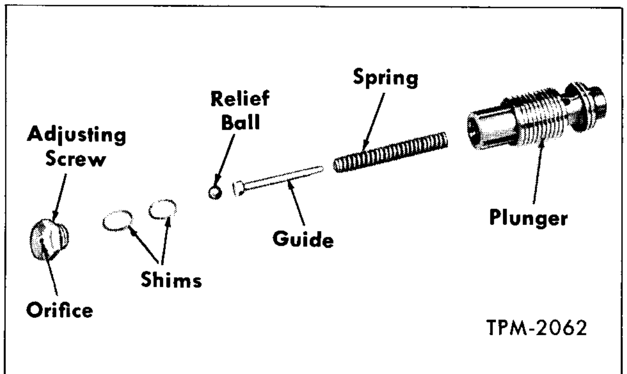


Figure 19—Flow Control Valve Components

3. Remove washer (9) and gasket (10) from reservoir cover (1). Discard gasket.

4. Lift reservoir cover and tube assembly (1) and cover gasket (13) from reservoir tank (14). Discard gasket (13).

5. Remove four bolts (4) attaching reservoir tank (14) to pump manifold (7); then remove reservoir tank (14), four spacers (8), and reservoir oil baffle (39).

6. Remove pump manifold to reservoir discharge (15) and return (37) gaskets. Discard gaskets.

7. Remove four manifold to pump attaching bolts (6), and remove manifold (7) from pump body (24) and pump cover (33). Remove manifold to pump discharge (16) and return (34) gaskets. Discard gaskets.

8. Remove four bolts (5) attaching pump cover (33) to pump body (24). Remove pump cover from pump body.

9. Lift flow control valve assembly (28), flow control spring (29), and seal ring (36) from pump cover (33). Discard seal ring (36).

10. If inspection shows necessity for removal, remove snap ring (32); then drive spring retainer plug (31) and seal ring (30) from pump cover (33). Discard seal ring (30).

11. Mark position of pressure plate (35) so it can be reassembled in same relative position; then remove pressure plate from locating pins (25) which extend through pump body to cover ring (26).

12. Mark position of pump body to cover ring (26) so it can be reassembled in same position in relation to pump body (24); then lift ring from locating pins (25).

13. Remove pump rotor (27), 12 rotor vanes (17), and seal ring (36) from pump body (24). Discard seal ring (36).

14. If inspection shows necessity for removal of locating pins (25), remove pins from pump body.

15. Using needle nose pliers, remove drive shaft bearing snap ring (21) from pump body (24).

16. Pull drive shaft outer bearing (22) and drive shaft (20) from pump body (24). It may be necessary to tap on end of drive shaft with plastic hammer to facilitate removal.

17. If inspection indicates necessity for removal of bearing oil seal (23) and drive shaft inner bearing (18), drive seal out of pump body with punch and hammer, then using care to avoid damage to inner surface of pump body, remove inner bearing from pump body by tapping out lightly with hammer and brass drift.

18. Remove drive shaft key (19) from slot in rotor drive shaft (20).

19. If inspection indicates necessity for replacement of outer bearing (22), press bearing off drive shaft (20) using a 1" I.D. sleeve.

20. If flow control valve assembly (fig. 19) is to be disassembled for inspection or cleaning purposes, maintain pressure on spring loaded plug to prevent loss of poppet relief ball. Be careful not to score ground surfaces of flow control valve.

21. Flexible line union fittings in pump cover should not be removed unless inspection indicates O-ring seals leak or fittings are damaged.

CLEANING AND INSPECTION

Key numbers in text refer to figure 18.

1. Clean all parts except drive shaft outer (22) and inner (18) bearings in cleaning solvent. Wipe parts dry with clean lint-free cloth. NOTE: Drive shaft outer bearing (22) is a sealed and shielded ball bearing. Washing bearing in solvent may dilute lubricant sealed into bearing.

2. Rotate bearings slowly by hand, feeling for roughness. Do not mistake dirt or grit in bearing for roughness. Examine bearings for wear or damaged balls. Replace bearings if not in good condition.

3. Check fit of vanes (17) in slots in rotor (27) for tightness or excessively loose condition. Vanes must slide freely but fit snugly in slots in rotor. Tight fit of vanes in rotor may sometimes be corrected by thorough cleaning. Replace rotor if excessive looseness exists between rotor and vanes. Replace vanes if worn or scored.

4. Examine machined surfaces of pump body to cover ring (26) for roughness or excessive wear. Replace ring if condition cannot be corrected with crocus cloth.

5. Inspect machined surfaces of pressure plate (35) and pump body for wear or scoring. Slight wear or scoring may be cleaned up by lapping. Lapping compound must be thoroughly washed off parts before they are reinstalled.

6. Inspect machined surfaces of flow control valve (28) for scoring or roughness. Check for freedom of movement of valve in bore of pump cover. Slight wear, nicks, or scores may be corrected with crocus cloth.

7. Make sure calibrated orifice in flow con-

trol valve plug is open.

8. Check flow control valve spring and relief valve spring for free length, compressed length, distortion, or collapsed coils. (See "Specifications."

9. Inspect oil passages in pump body, cover, pressure plate, and cover to body ring for obstructed passages. Clean passages if this condition is found.

10. Check locating pins (25) for distortion.

ASSEMBLY

Key numbers in text refer to figure 18.

Lubricate each moving part with clean recommended hydraulic fluid before part is installed. When assembling power steering pump, use new gaskets and O-ring seals.

1. If flow control valve assembly (fig. 19) has been disassembled, assemble parts, making sure same number of shims are installed as were removed. These shims control pressure at which relief valve opens to 950-1000 psi pressure. Tighten relief valve adjusting screw to 80-100 inch-pounds torque.

2. If drive shaft outer bearing (22) was removed from drive shaft (20), press bearing on shaft, using a sleeve with 1" I.D. Install bearing on shaft with stamped face of inner race toward threaded end of shaft.

3. If drive shaft inner bearing (18) was removed from pump body (24), install bearing in pump body by tapping lightly on bearing outer race. Make sure bearing is fully seated in pump body.

4. If bearing oil seal (23), was removed from pump body (24), install new oil seal in bore of pump body. Use a sleeve with 1-5/8" diameter to bear against outer edge of seal when driving into position. Install seal with stamped side facing out. Make sure seal is properly seated in pump body.

5. Install drive shaft (20) and outer bearing (22) in bore of pump body (24). Tap lightly on outer race of bearing until bearing is fully seated; then install snap ring (21) in pump body.

6. If locating pins (25) were removed at pump disassembly, install new pins in pump body (24).

7. Install new sealing ring (36) in groove of pump body (24).

8. Install pump rotor (27) over splines of drive shaft (20); then position vanes in slots in rotor with beveled edges of vanes facing seal ring (36).

9. Carefully position pump body to cover ring (26) over pump rotor (27) and vanes (17) aligning marks made at disassembly. NOTE: Observe body to cover ring (26) which has arrows cast onto outer edge. Pump body to cover ring (26) must be positioned on locating pins (25) with these arrows pointed in a counterclockwise direction when pump is viewed from the drive end.

10. Position pressure plate (35) over locating pins (25) against pump body to cover ring (26), aligning marks made at disassembly.

11. Place new O-ring seal (36) around pressure plate surface of pump body to cover ring (26).

12. Install new seal ring (30) in groove of spring retainer plug (31); then install plug into bore of pump cover (33). Secure plug with snap ring (32).

13. Position flow control valve spring (29) and flow control valve (28) in bore of pump cover (33).

14. Place pump cover (33) over pressure plate (35) against pump body to cover ring (26), aligning pump cover with pump body.

15. Install four bolts (5) attaching pump cover to pump body. Tighten bolts evenly to 25-30 foot-pounds torque. Turn pump rotor drive shaft to check for freeness.

16. Install drive shaft key (19) in slot of rotor drive shaft (20). Secure with tape.

17. If flexible line union fittings and O-ring seals were removed from pump, install new seals and fittings in pump cover. Plug or mask fittings to keep dirt or foreign material out of pump until pump is ready to be installed on engine.

18. Position new manifold to pump discharge (16) and return (34) gaskets on pump assembly; then attach pump manifold (7) to pump with four attaching bolts. Tighten bolts to 3-1/2 to 4 foot-pounds torque.

19. Position new manifold to reservoir discharge (15) and return (37) gaskets on manifold; then position reservoir tank (14) on manifold (7).

20. Position oil baffle (39) over discharge hole at bottom of reservoir tank (14); then install four attaching bolts (4) and spacers (8). Tighten bolts to 3-1/2 to 4 foot-pounds torque.

21. Place reservoir cover (1) and tube assembly and new gasket (13) on reservoir tank.

22. Position new gasket (10) and washer (9) over reservoir cover bolt.

23. Install dipstick and plug assembly (2) in reservoir cover and tube assembly.

24. Position chain on dipstick and plug assembly over reservoir cover bolt; then install wing nut on bolt. Tighten wing nut firmly.

POWER STEERING FLUID FILTER

Power steering fluid filter assembly is bracket mounted to engine bulkhead (fig. 4).

At regular lubrication intervals, fluid filter bowl should be removed and element cleaned. Any time power steering fluid filter has been serviced, power steering hydraulic system should be bled. Refer to "Bleeding Power Steering Hydraulic System" explained earlier in this section.

SERVICING FILTER

NOTE: The filter assembly can be serviced without removing complete assembly from coach.

1. Using a wrench, turn filter bowl out of threads of filter head.

2. Remove and discard filter bowl gasket.

3. With a small wrench, unscrew filter element assembly from filter head. Use care to avoid damage to element. Clean parts, using cleaning solvent and compressed air.

4. Remove fluid filter drain plug from bottom of filter bowl. Clean all metallic material from plug magnets.

5. Reassemble filter; then bleed hydraulic system as directed earlier under "Bleeding Power Steering Hydraulic System."

POWER STEERING SYSTEM SPECIFICATIONS

HYDRAULIC PUMP

Make	Vickers
Model	VT36-100-40-95-40-10S4—L.H.
Type	Hydraulic Vane
Capacity	4 Gal. per Minute at 1200 R.P.M. and Zero Pressure
PUMP ROTOR	
Width	0.6139"
Outside Diameter	1.588"-1.598"
Number Vane Slots	12
Vane Slot Width	0.0780"-0.0785"
ROTOR VANES	
Quantity	12
Thickness	0.0775"
Width	0.0343"
Length	0.6136"
OUTER BEARING	
Type	Single Row Ball
Make	N.D.-954211
Outside Diameter	1.8499"-1.8504"
Inside Diameter	0.7874"-0.7870"
INNER BEARING	
Type	Single Row Ball
Make	N.D.-903201
Outside Diameter	1.2593"-1.2598"
Inside Diameter	0.4721"-0.4724"
Flow Control Valve	
Opening Pressure	950 to 1000 psi
Shim Thickness	0.030" and 0.045"
Springs	
Flow Control Valve Spring	
Free Length	2.506"
Compressed Length Under 6.25 lbs.	0.906"
7.7 lbs.	0.531"
Relief Spring	
Free Length	1.591"
Compressed Length Under 19.6 lbs.	1.3125"
21.78 lbs.	1.2812"

POWER STEERING BOOSTER CYLINDER

Make	Vickers
Model	SP3-210B
Type	Hydraulic
Adjustable Length (Disconnected and Fully Retracted)	
Center of Stud at Each End	$26\frac{25}{32}$"
Cylinder Tube—Inside Diameter (Low Limit Preferred)	2.750"-2.756"
Outside Diameter	$3\frac{1}{8}$"
Length	$14\frac{23}{32}$"
Piston	
Outside Diameter	2.748"
Clearance—Piston to Cylinder	0.002"-0.010"
Ring Groove—Width	0.187"-0.188"
Depth	$\frac{1}{8}$"
Piston Ring	
Width	0.1860"-0.1865"
Wall Thickness	0.103"-0.113"
Outside Diameter (When Compressed)	2.750"
Gap (When Compressed to 2.750")	0.007"-0.017"
Piston Rod	
Finish	Chrome Plated
Stroke	$12\frac{1}{2}$"
Diameter	1.1245"
Piston Rod Bushing (In Cylinder Cap)	
Inside Diameter	1.128"-1.129"
Outside Diameter	1.378"-1.379"
Width	1.120"-1.130"
Booster Cylinder Extension and End Socket Adjusted Length (Centerline of End Socket Tapered Stud to Outside Edge of Flange)	
TDH-4516, TDH-5301, and TDM-5301	28"
TDH/TDM-4517, TDH/TDM-5302, SDH/SDM-4501, and SDH/SDM-5301	22"
Springs	
Valve Centering Spring (Outer)	
Free Length	1.293"
Compressed Length Under 160 lbs.	1.093"
Compressed Length Under 260 lbs.	0.968"
Valve Centering Spring (Center)	
Free Length	1.044"
Compressed Length Under 106 lbs.	0.843"
Compressed Length Under 172 lbs.	0.718"
Valve Centering Spring (Inner)	
Free Length	1.042"
Compressed Length Under 54 lbs.	0.843"
Compressed Length Under 88 lbs.	0.718"
Check Valve Ball Spring	
Free Length	1.059"
Compressed Length Under 0.4 lbs.	$\frac{7}{8}$"
Oil Passage Tube Spring	
Free Length	0.536"
Compressed Length Under 9 lbs.	0.375"
Steering Booster Ball Stud Outer Seat Spring	
Free Length	$\frac{23}{32}$"
Compressed Length Under 185-238 lbs.	$\frac{1}{2}$"
R.H. Socket Stud Spring	
Free Length	1.25"
Compressed Length Under 250 lbs.	0.88"

STEERING GEAR

Make	Saginaw
Type	Recirculating Ball and Sector Nut
Gear Ratio	25.6 to 1
Model	
Early Type Gear	572-D-3
Late Type Gear	572-D-1

POWER STEERING SYSTEM SPECIFICATIONS (CONT.)

Adjustments
Worm Bearings
Adjustment Type....................Shims
Shim Sizes Available..........0.002″, 0.005″, 0.010″, and 0.030″
NOTE: Use a minimum of (3) 0.002″ and (2) 0.005″ thick shims.
End Play in Worm....................None
Pull to Keep the Worm Moving
(Early Type Gear only)..........6¾ to 9 in. lbs.

Pitman Shaft Lash
Adjustment Type..........Adjuster Screw
Pull Through Center (Early Type Gear only)
(Includes Worm Bearing Load)..........16 in. lbs. max.
Back-Up Adjuster....Screw in until adjuster bottoms; then back off ¼ turn and tighten lock nut to 30-50 foot-pounds torque.

Reverse torque at Pitman shaft (Early Type Gear only) to be 45-60 ft.-lbs. thru center.
NOTE: Balance of steering gear specifications are the same as described previously under "Mechanical Steering Specifications."

STEERING DRAG LINK

Type....................Adjustable Length

Length—Stud Centers (Approx.)..........9.12″

Springs
Stud Seat Spring
Free Length....................0.750″
Compressed Length Under 350-400 lbs..........0.390″

Springs (Cont.)
Socket Centering Spring
Free Length....................1.250″
Compressed Length Under 30 lbs..........0.875″

TORQUE SPECIFICATIONS

Location	Ft.-Lbs.
Relief Valve Adjusting Screw	80-100 in. lbs.
Pump Reservoir to Manifold Bolt	3½-4
Manifold to Pump Bolt	3½-4
Cover to Pump Body Bolt	25-30
Booster Cylinder thru Bolt Nuts	20-25
Booster Cylinder Flange to Extension Flange Bolts and advance torque to nearest cotter pin hole	40-50
Drag Link to Booster Cylinder Ball Stud Nut and advance in torque to nearest cotter pin hole.	150
Piston Rod End Socket Stud to Support Bracket Stud Nut and advance in torque to nearest cotter pin hole.	150
Extension End Socket Stud to Steering Arm Nut and advance in torque to nearest cotter pin hole.	150
Drag Link Stud to Pitman Arm Nut and advance in torque to nearest cotter pin hole.	150
Piston Rod End Socket to Piston Rod Bolt	100

NOTE: Balance of torque specifications are listed previously in this section under "Mechanical Steering System Specifications."

Keep Steering Linkage Properly
Adjusted and Attaching Bolts and Nuts
Properly Torqued. See "Specifications."

Transmission

SPICER 4-SPEED MECHANICAL

DESCRIPTION

GENERAL

Mechanical transmission (fig. 1) is mounted directly to engine assembly. Power input is through 63-degree angle drive gears which are enclosed in a portion of the clutch housing. Clutch housing, transmission case, and cover are of cast aluminum alloy. Cast iron inserts are employed where additional strength is required. Angle drive gears are spiral bevel type. All mainshaft, countershaft and reverse idler gears are constant mesh type with helical teeth.

The transmission gears are shifted manually through use of gearshift lever located at right of driver's seat and connected to levers on transmission by rods and bell cranks (figs. 4 and 5).

Shift forks in transmission cover (fig. 15) engage sliding clutches (fig. 12) and the clutches lock gears to respective shafts to provide the power train for each speed.

Transmission lubricant is contained in reservoir (sump) on bottom of transmission case. Lubricant is circulated to various points by a gear type pump mounted on engine and connected to transmission by flexible lines (fig. 3).

On vehicles with wet type clutch, the drive pinion has drilled passages (inset in figure 11) to carry lubricant to clutch components and pilot bearing (bushing) at engine flywheel.

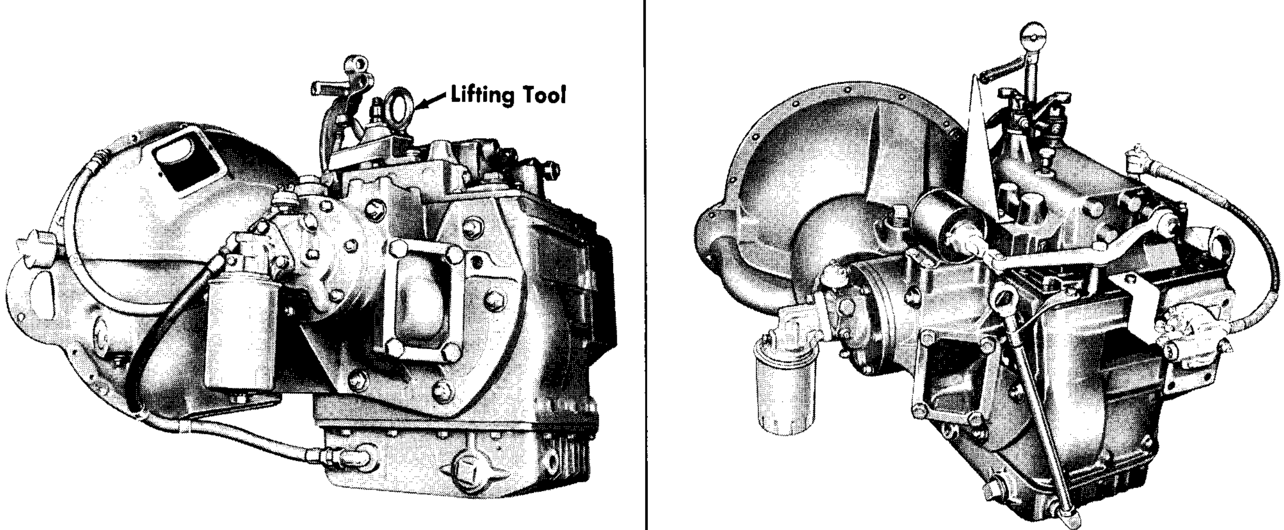
Additional information on lubrication system and pump is included later under "Lubrication System."

The terms "Front" and "Rear" as used in this section do not refer to mounted position of transmission in coach. "Front" refers to the input or engine end of transmission while "Rear" refers to output or propeller shaft end of transmission. View of levers and propeller shaft yoke is shown in figure 2.

Key numbers in following descriptions refer to figure 13 except as otherwise indicated.

MAINSHAFT, GEARS, AND BEARINGS

Front end of mainshaft (36) is supported by pilot bearing (14) located in pocket in drive gear (15). Mainshaft rear bearing (43) which takes endwise thrust and carries radial load is installed in retainer (44). Rear bearing cap (34) locks bearing outer race in retainer. Lip of oil seal (35) in bearing cap (34) prevents lubricant leakage and seals out dirt. Speedometer drive gear (31) contacts inner race of bearing (43) and gear is locked in place by yoke assembly (41). Speedometer driven gear



TRANSMISSION WITH DRY CLUTCH | TRANSMISSION WITH WET CLUTCH

Figure 1—Mechanical Transmissions

(42) is installed in bearing cap (34) and is held in place by sleeve (2, fig. 2).

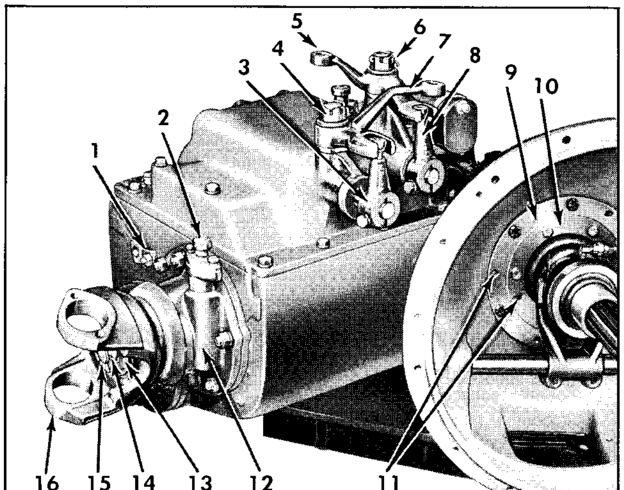
Mainshaft 3rd and 4th speed clutch gear (80) is mounted on splined portion of mainshaft and held in place with mainshaft gear retaining nut (16) and lock (81). First and 2nd speed clutch gear is integral with mainshaft.

Mainshaft 1st (21), 2nd (19), and 3rd (18) speed constant mesh gears are each mounted on double row needle bearings. Rows of bearings are separated by spacers.

Oil tube (13) in drive gear (15) supplies lubricant to drilled passage in mainshaft from which lubricant is distributed to bearings and to speedometer gears. Sliding clutch (27) is shifted to provide 1st and second speeds and sliding clutch (79) is shifted to provide 3rd and 4th speeds. Figure 12 shows view of gears in transmission case.

COUNTERSHAFT AND GEARS

Countershaft (52) is supported at rear by single row ball bearing (50) held on shaft with two lock nuts (45 and 51) and nut lock (54). Front end of shaft is supported on countershaft front roller bearing (78) which is prevented from coming out of



1 Reverse Idler Shaft Lock
2 Speedometer Drive Sleeve
3 1st, 2nd, and Reverse Outer Finger
4 Nut, Washer, and Cotter Pin
5 3rd and 4th Shift Lever
6 Nut, Washer, and Cotter Pin
7 1st, 2nd, and Reverse Lever
8 3rd and 4th Outer Finger
9 Bearing Retainer
10 Pinion Bearing Cap
11 Puller Screw Hole
12 Mainshaft Bearing Cap
13 Washer
14 Cotter Pin
15 Mainshaft Nut
16 Propeller Shaft Yoke

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Figure 2—Transmission Showing Shift Levers and Propeller Shaft Yoke

case by clutch housing (82). Inner race of roller bearing (78) is held on shaft by countershaft nut (77) and retaining washer (76).

Countershaft drive gear (68) and countershaft 3rd speed gear (66) are keyed to shaft and separated by spacer (70). Countershaft 2nd speed gear (72) and countershaft clutch gear are integral with shaft.

Countershaft 1st speed gear (49) is not keyed to shaft, but is carried on bronze bushing (47) and is driven by countershaft sliding clutch (48) carried on countershaft clutch gear. Countershaft sliding clutch is operated by reverse shift fork and is engaged in all forward speeds.

REVERSE IDLER GEAR

Reverse idler driving and driven gears (60 and 64) are mounted on roller bearings, with two rows of bearings in each gear separated by spacers.

Reverse idler gears are separate, revolving independently of each other in all forward speeds. Reverse idler drive gear is in constant mesh with countershaft 2nd speed gear (72) and reverse idler driven gear (60) is in constant mesh with mainshaft 1st speed gear (21). Reverse idler sliding clutch (62) is carried on hub of reverse idler driving gear, and engages both gears during reverse operation (fig. 14). Thrust washers (59 and 65) are installed between respective gears and adjacent portion of transmission case.

DRIVE GEAR AND BEARINGS

Drive gear (15) is supported at transmission case by roller bearing assembly (12). Bearing is held in place by retainer (10) which is bolted to transmission case. Seal (11) prevents leakage between retainer and clutch housing (82). Tapered roller bearings are used at outer end of drive gear. Outer bearings are adjustable, and shims (4) are used to provide proper contact between bevel pinion gear and bevel drive gear (83) keyed to shaft which is integral with drive gear (15). Oil tube (88) carries oil supplied by pump (fig. 3) to lubrication passage in drive gear. Passage is shown by dotted lines. Bearing cap assembly (1) incorporates a lubrication pressure relief valve and is machined for mounting lubricating oil filter assembly (fig. 3).

BEVEL GEARS AND BEARINGS

Key numbers in text refer to figure 11 unless otherwise indicated.

Bevel drive gear (12) is installed on front end of drive gear (21). Key (7) in drive gear shaft is engaged with keyway in gear. Bevel drive gear (12) is driven by drive pinion (1). At clutch housing (27) drive pinion (1) is mounted on opposed tapered roller bearings which are installed in retainer (3). Spacer (5) and shims provide means for adjusting the bearing preload. Nut (35) holds bearings in

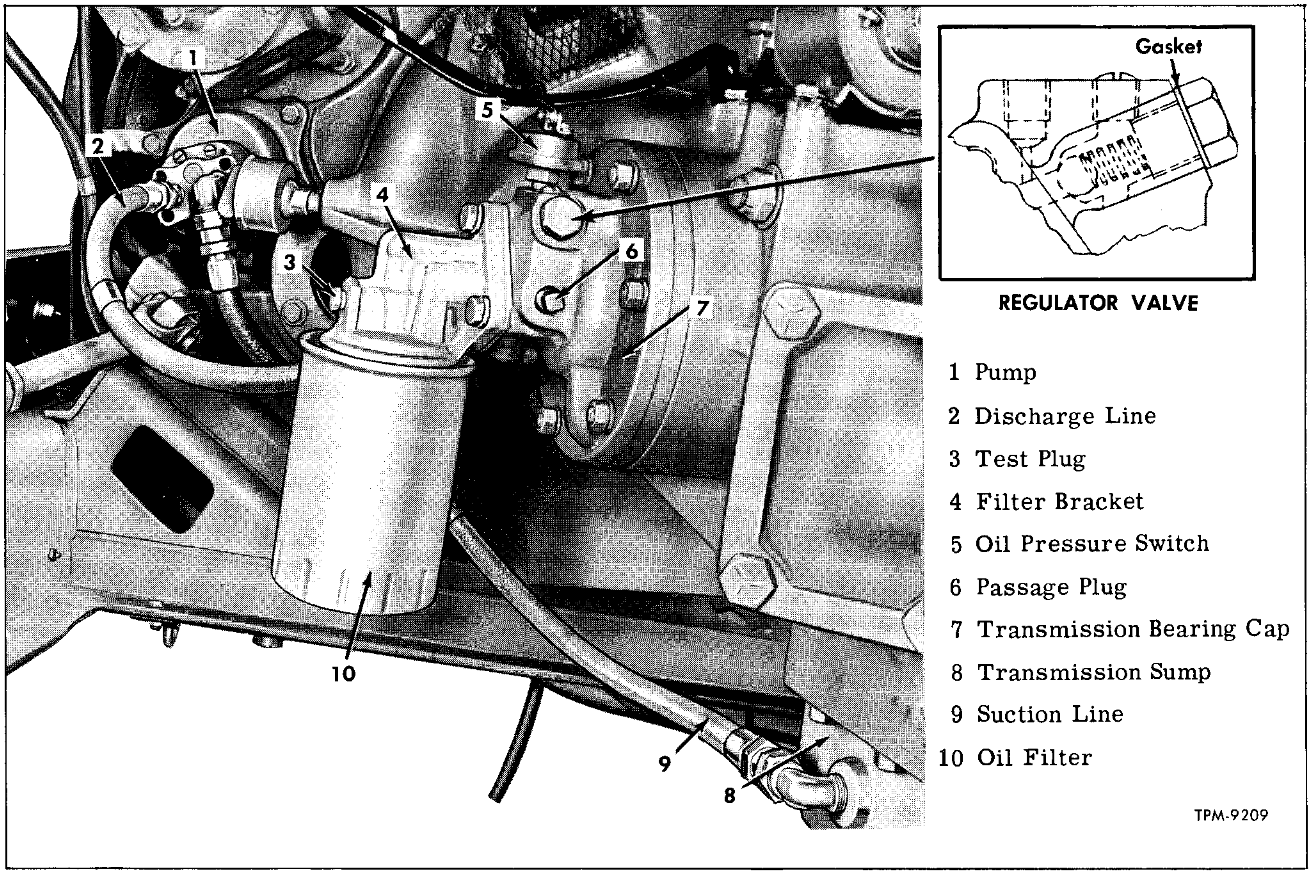


Figure 3—Transmission Oil Filter Lines and Pump

place on drive pinion. Oil tube (26) pressed into housing (27) carries lubricant to drilled passage in drive pinion to lubricate drive pinion bearings. Shims (16 and 32) are used to adjust gear backlash and gear tooth contact.

Refer to applicable sub-section in CLUTCH (SEC. 5) for method of support at front end of drive pinion.

COVER, SHIFT LEVERS, AND FORKS

Key numbers refer to figure 15 unless otherwise indicated.

External levers and fingers at transmission cover (fig. 2) are operated by transmission gearshift lever and linkage. Inner fingers (7 and 12) engage notches in shift forks. Three shift forks (1, 10, and 13) are clamped to shift rods (15, 16, and 17). Sleeves (5 and 9) on shift rods prevent overshifting, and spring-loaded poppet balls in cover engage notches in top of shift rods to lock the rods into proper position. Interlocks prevent lock-up of transmission by preventing engagement of two gears at once.

Reverse solenoid and lever (fig. 6) move shaft (4) endwise to engage inner finger (12) with notch in fork (13) when shifting into reverse. Spring (11) returns finger (12) to notch in 1st and 2nd shift fork when shifting transmission out of reverse. A breather assembly is installed in transmission cover on coaches with wet clutch. On other vehicles the breather is located in threaded opening in inspection plug in angle drive section of clutch housing.

LUBRICATION SYSTEM (Fig. 3)

Lubricant which lubricates transmission is contained in oil reservoir bolted on bottom of transmission case. The pump (fig. 3), is mounted on and driven by the engine. Oil from reservoir is drawn to pump through suction line, and is discharged through line to oil filter assembly on transmission. Located in bearing cap (7, fig. 3) is a spring-loaded pressure regulator valve which maintains pressure at switch (5, fig. 3) at low engine speed. Lubricant is directed through oil passages to lubricate transmission bearings and gears.

On coaches with 6V-71 engine and wet type clutch, the drive pinion shaft is drilled lengthwise and clutch components are lubricated by oil pumped through oil passage in drive pinion. With wet clutch, a restricted fitting is used in oil tube in bearing cap (1, fig. 3) and in front (engine) end of

drive pinion shaft. Lubricant drains through screen (71, fig. 13) into reservoir.

Filter element is disposable type which is screwed onto threaded nipple on filter mounting base. A by-pass valve is provided in filter base to allow oil to by-pass the filter element and continue to lubricate transmission parts if filter element becomes clogged.

A switch (5, fig. 3) mounted on transmission lights a tell-tale on instrument panel to warn driver in case transmission oil pressure drops below safe operating pressure (1-1/2 to 2-1/2 psi).

TRANSMISSION CONTROLS

Selection of transmission gear is made by conventional shifting lever. Gearshift lever is mounted in a tower attached under floor near driver's seat. Two shift rails in base of gearshift lever tower are connected with control rods which are shown in figure 4. Shift rods are connected to bellcrank levers at engine compartment bulkhead. Shift rods have adjustable clevises at forward ends. Two rods in engine compartment connect bellcrank levers to shift levers on transmission cover. Gearshift lever movement is transmitted to transmission through the rods, bellcranks and levers. Figure 5 shows the construction of controls at engine compartment bulkhead.

Rods are supported in looms which pass through grommets installed in holes in brackets and bulkheads. A bellows-type seal is used at front and at rear of each shift rod loom to seal out dirt and moisture.

Reverse solenoid is mounted on transmission and connected to lever (fig. 6) which moves 1st, 2nd, and reverse shaft endwise. Solenoid is energized by a button type switch at panel at left of driver which operates relay located in electrical compartment at R.H. rear corner of coach. Relay completes circuit to the reverse solenoid. When solenoid is energized, solenoid plunger which is linked to reverse lever (8, fig. 6) pulls on reverse lever and forces shift finger shaft endwise to disengage inner finger from notch in 1st and 2nd fork and engage finger with reverse shift fork. This action can take place only when gearshift lever is in the 1st speed position. See figure 4 for shift diagram.

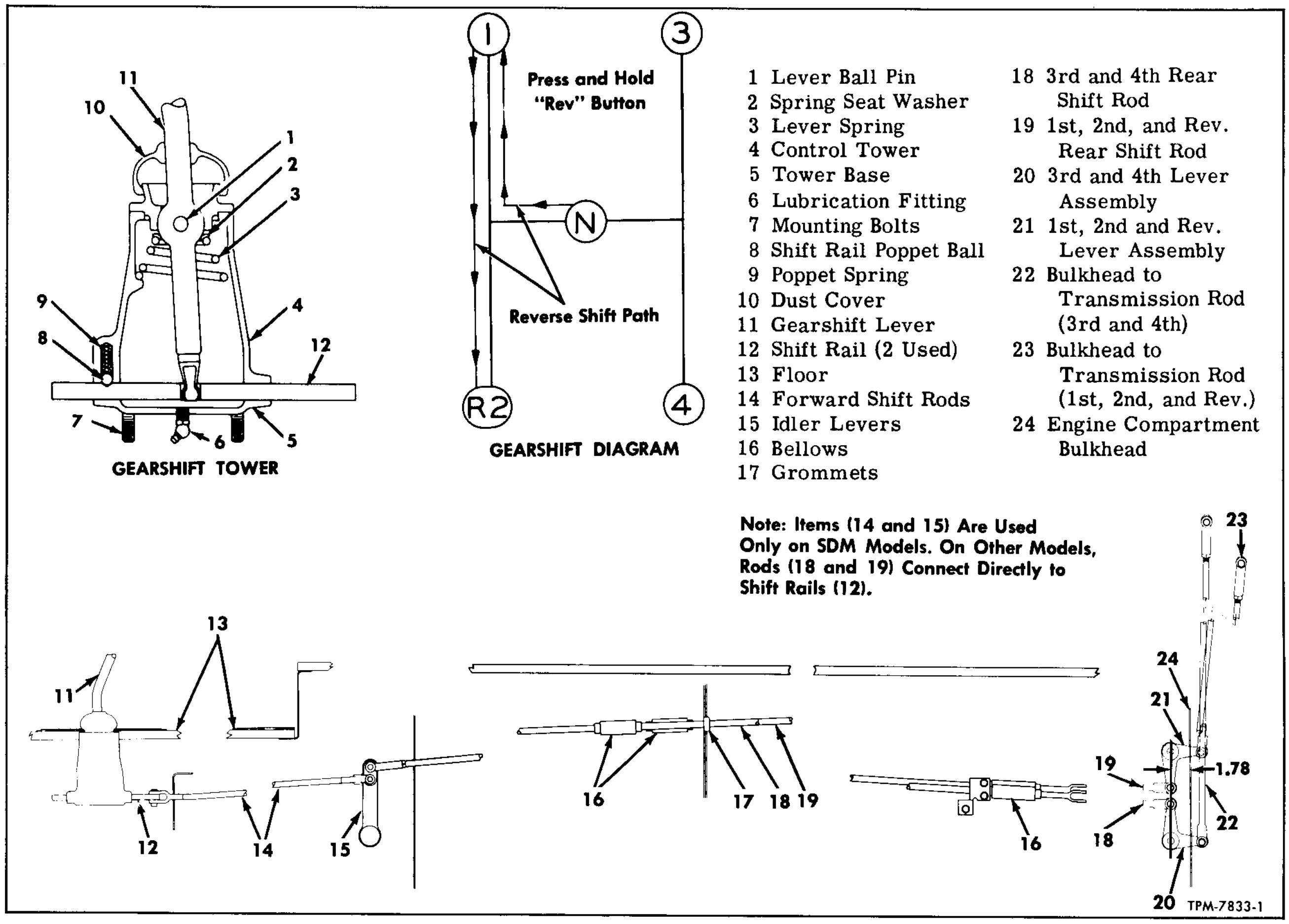


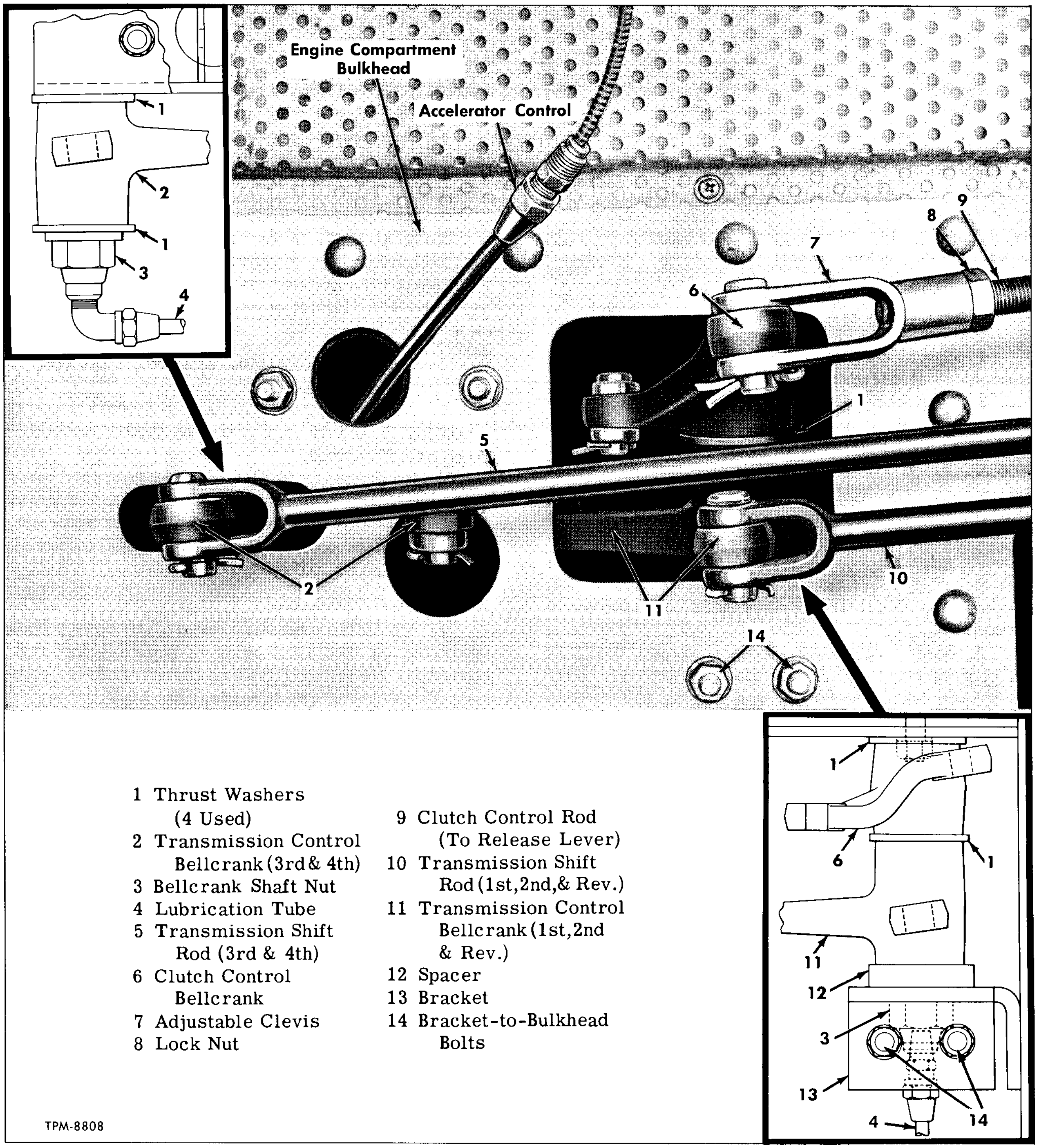
Figure 4—Transmission Controls

TRANSMISSION AND CONTROL MAINTENANCE

CONTROL ROD ADJUSTMENT

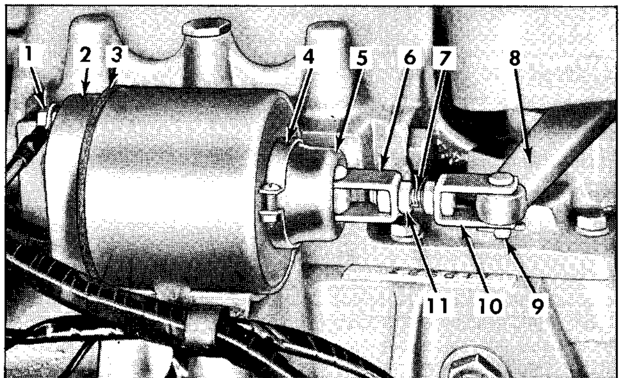
Key numbers in text refer to figure 4, except as otherwise indicated.

Provisions are made for adjustment of rear control rod length by use of adjustable yokes. When replacing transmission or any of the control linkage, before attempting to operate vehicle, be sure linkage is adjusted as follows:



1 Thrust Washers (4 Used)
2 Transmission Control Bellcrank (3rd & 4th)
3 Bellcrank Shaft Nut
4 Lubrication Tube
5 Transmission Shift Rod (3rd & 4th)
6 Clutch Control Bellcrank
7 Adjustable Clevis
8 Lock Nut
9 Clutch Control Rod (To Release Lever)
10 Transmission Shift Rod (1st, 2nd, & Rev.)
11 Transmission Control Bellcrank (1st, 2nd & Rev.)
12 Spacer
13 Bracket
14 Bracket-to-Bulkhead Bolts

Figure 5—Control Mechanism At Engine Compartment Bulkhead



1 Terminal
2 Cover
3 Felt Gasket
4 Clamp
5 Dust Shield
6 Link Assembly
7 Bolt
8 Reverse Lever
9 Clevis Pin
10 Clevis
11 Lock Nut

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Figure 6—Typical Reverse Solenoid and Linkage

1. Place gearshift lever in neutral position and disconnect rods from levers on transmission (fig. 2).

2. With clevises at ends of shift rods (18 and 19) connected at both ends, observe position of bellcrank lever assemblies (20 and 21) at engine compartment bulkhead. Center of clevis pins must be in line with each other and centered on a line through the two shaft assemblies. This line is 1.78 inches from bulkhead as shown in figure 4. If necessary, adjust clevises at front end of rods (18 and 19) to bring about the condition described above. Tighten lock nuts at clevises when adjustment is completed.

3. With transmission levers (5 and 7, fig. 2) in neutral position, adjust clevises on bellcrank-to-transmission rods (22 and 23) so clevis pins can be installed without moving gearshift lever or transmission shift levers out of neutral position.

4. With engine running, try shifting transmission into each gear. If there is evidence of binding or other difficulty in shifting, make necessary corrections.

CONTROL LUBRICATION

1. Fittings are provided for lubricating gearshift control tower, transmission linkage idler levers (when used), and bellcrank levers. Refer to LUBRICATION (SEC. 13) in this manual for lubrication instructions.

2. Pivot points in linkage must be oiled periodically to keep them in free working condition.

CONTROL TOWER REPLACEMENT

Gearshift lever, mounted in control tower below floor at right of driver, can be removed and disassembled as described below. Mounting bolts and clevis pins are accessible below vehicle. Refer to figure 4 for layout of control rods.

Removal

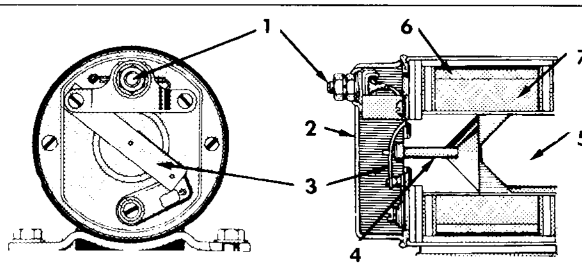
1. Remove clevis pins attaching shift rods to shift rails in shift tower.

2. Remove parts attaching gearshift tower to mounting brackets and remove tower assembly from below vehicle.

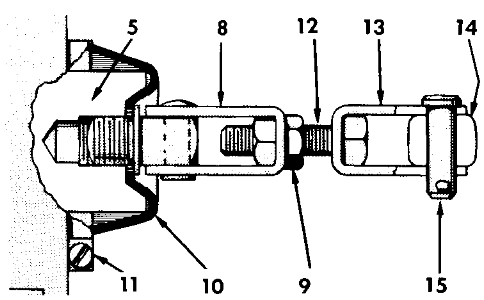
3. If necessary to disassemble gearshift lever tower, the cap may be removed from top of tower to permit removal of lever, and the four bolts may be removed at bottom of the assembly to permit removal of shift rails and poppets.

Installation

1. Assemble gearshift lever tower components referring to sectional view in figure 4 for construction. Mounting bolts are installed from upper side of tower and are threaded into base.



SECTIONAL VIEWS OF REVERSE SOLENOID



SOLENOID LINKAGE

1 Wire Terminal
2 Cover
3 Contact Points
4 Pin
5 Plunger
6 Holding Coil
7 Pulling Coil
8 Link Assembly
9 Lock Nut
10 Dust Shield
11 Clamp
12 Adjusting Bolt
13 Clevis
14 Lever
15 Clevis Pin

TP 2938

Figure 7—Reverse Solenoid Adjustment

2. Place gearshift tower in position at support bracket. Install attaching parts and tighten bolts firmly. Connect shift rods to shift rails on gearshift tower assembly.

3. Lubricate the assembly through fitting in bottom of tower base.

REVERSE SOLENOID AND LINKAGE ADJUSTMENT

Whenever the reverse solenoid has been removed or if difficulty is experienced when shifting transmission into reverse speed, the following procedure will properly adjust the solenoid linkage:

1. Be sure transmission control linkage is properly adjusted.

2. Place gearshift lever in 1st speed position.

3. Disconnect wire from terminal and remove cover from solenoid. Inspect contact points. If points are burned or pitted, replace points or dress with a fine cut point file.

4. Try operating lever (8, fig. 6) while observing contact points (3, fig. 7). As lever pushes plunger (5, fig. 7) inward, plunger must contact pin (4, fig. 7) and open points when plunger reaches end of stroke. When current is supplied to solenoid both coils (6 and 7, fig. 7) are energized and cause magnetic pull on plunger; but when points open, the circuit through pulling coil (7) is broken and only the holding coil (6, fig. 7) remains energized. Damage to coils may occur if points do not open at end of plunger stroke.

5. If necessary to make an adjustment, refer to figure 6 and loosen lock nut (11), remove clevis pin (9) and turn clevis (10) while holding link assembly (6). Install clevis pin and tighten lock nut, then recheck action as directed in Step 4 above.

6. Finally, start engine and check operation of the transmission controls.

LUBRICATION SYSTEM MAINTENANCE

OIL FILTER ELEMENT REPLACEMENT

Key numbers in text refer to figure 3.

The oil filter assembly is mounted at base by three bolts threaded into transmission bearing cap. The element is disposable type which threads onto a nipple on filter base.

At intervals specified in LUBRICATION (SEC. 13) in this maintenance manual replace filter element as follows:

1. Use a wrench on the "hex"-shaped lower end of element and turn the element cartridge counterclockwise and remove from base.

2. Wipe filter base with clean cloth and check base mounting bolts to see that they are tight.

3. Oil the mating rubber surface on new filter cartridge gasket, then screw cartridge onto base. Torque to 10-15 foot-pounds. Do not overtighten.

4. Start engine and after running several minutes, check oil level on dipstick. Add oil as required to fill transmission to "OIL LEVEL" mark on dipstick.

Inspect filter for evidence of leakage.

LOW OIL PRESSURE SWITCH

To determine if low oil pressure switch (10, fig. 9) is functioning properly, turn on driver's master switch to either "Day" or "Nite" position. With engine stopped, the "TRANS. OIL" tell-tale should be illuminated. When engine is running, the tell-tale should not be illuminated.

If the tell-tale does not illuminate with engine stopped, connect a jumper wire between the switch terminals. If tell-tale does not light with jumper in place, the wiring or tell-tale bulb is defective. Refer to ELECTRICAL SYSTEM (SEC. 7) in this Maintenance Manual, for required information and replace bulb or make necessary repairs.

If tell-tale does light with jumper wire connected across switch terminals, the switch is defective and must be replaced.

To determine if a switch is functioning properly, connect switch in series with battery and light bulb, and connect switch to a hydraulic pressure port equipped with a gauge and means for varying the pressure.

With no pressure applied, the bulb should light. As pressure rises the bulb should "go out" at 1 to 2 psi.

Replace switch in case of malfunction.

TRANSMISSION OIL PUMP AND LINES

CHECKING PUMP PRESSURE AND CAPACITY

Fluid pump is gear type, mounted at rear of engine, and driven by coupling from accessory drive gear (fig. 8).

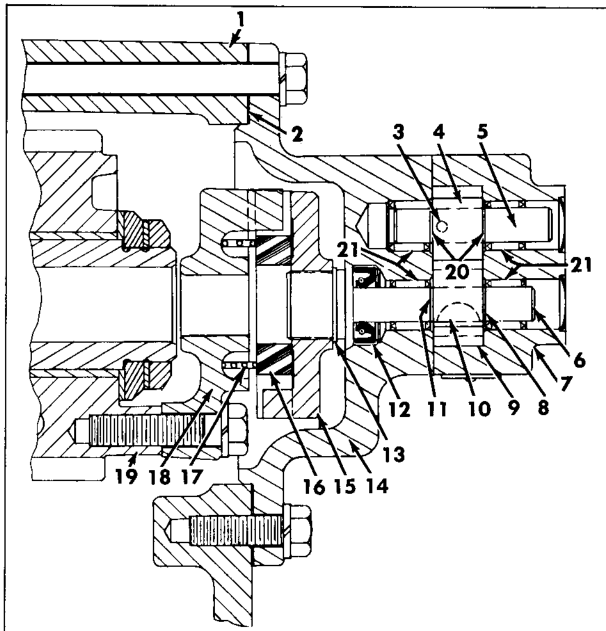
To check pump pressure, remove test plug (3, fig. 3) and connect pressure gauge. Start engine and operate at 2000 rpm. Note gauge reading which should be 20 to 60 psi if oil is cold, or 10 to 20 psi if oil is warm.

To check pump capacity, disconnect line (2, fig. 3) from fitting at oil filter, then start engine and run at 400 rpm. Oil from disconnected line should fill a one-quart measure in 10 to 12 seconds if pump is in satisfactory condition.

If tests indicate that pump is not functioning properly, remove, and overhaul or replace pump assembly.

PUMP REMOVAL (Fig. 3)

1. Disconnect suction and discharge lines (9



1	Gear Train Cover	12	Oil Seal
2	Gasket	13	Snap Ring
3	Gear Pin	14	Pump Body
4	Driven Gear	15	Driven Hub
5	Driven Gear Shaft	16	Coupling
6	Drive Gear Shaft	17	Coupling Spring
7	Pump Body Cover	18	Drive Hub
8	Snap Ring - Outer	19	Accessory Drive Gear
9	Drive Gear	20	Snap Rings
10	Gear Key	21	Bearing Assemblies
11	Snap Ring - Inner		

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Figure 8—Oil Pump and Coupling

and 2). If there is oil in reservoir on transmission tie the end of suction line up above oil level to prevent oil from draining out while line is disconnected.

2. Remove six bolts and lock washers attaching pump assembly to gear train cover, then remove pump assembly and discard gasket.

3. Remove driven hub, coupling spring, and coupling. If necessary to remove drive hub (18, fig. 8) remove bolts and lock washers which hold drive hub to accessory drive gear.

PUMP DISASSEMBLY

Key numbers in text refer to figure 8.

1. Remove eight machine screws which hold two parts of pump body together. Tap with soft hammer to separate the cover (7) from body (14).

2. Remove idler gear and shaft assembly.

3. Remove outer snap ring (8) from drive gear shaft (6), then remove drive gear (9) and key (10). Remove inner snap ring (11) and pull drive gear shaft (6) out of body.

4. If inspection indicates that bearings, gears or oil seal requires replacement, further disassembly is possible. Removal of snap rings (20) and pin (3) permits removal of gear (4) from shaft (5). If bearing assemblies (21) require replacement, they may be removed from cover (7) and body (14) and new bearing assemblies can be pressed into place.

CLEANING AND INSPECTION

1. Clean all pump components thoroughly, using cleaning solvent. Be sure that bearings are clean.

2. Inspect shafts at areas contacted by bearings and oil seal for evidence of wear.

3. Inspect pump gears for wear, nicks, or other damage that would render these parts unfit for further service.

4. Inspect both halves of pump body for evidence of wear at points contacted by gears.

PUMP ASSEMBLY

Key numbers in text refer to figure 8.

During assembly operations apply engine oil freely to all parts to prevent rusting and provide initial lubrication.

1. Install oil seal (12) with seal lip toward mounting flange.

2. Press bearing assemblies (21) into place in body and cover.

3. Insert drive gear shaft (6) through oil seal (12) using care to avoid damage to seal. Install inner snap ring (11) and gear key (10) in shaft (6), then install gear and retain with outer snap ring (8).

4. If driven gear (4) has been removed from shaft, install gear and retain with pin (3) and snap rings (20).

5. Set driven gear and shaft assembly in place with short end in bearing in body (14).

6. Apply lead sealer on contact surfaces, then place body cover assembly at body and install eight machine screws. Tighten screws alternately and firmly to seat cover firmly at body.

PUMP INSTALLATION (Fig. 3)

1. Install driven hub on pump shaft splines.

2. Install gasket to pump body.

3. Install coupling spring in drive hub, then install coupling.

4. Position pump assembly to gear train cover, using care that coupling mates with drive hub and driven hub. Refer to figure 8.

5. Secure pump with cap screws and lock washers.

6. Connect suction and discharge lines (2 and 9) at locations shown. If suction line (9) has been removed, clip line at clutch housing. Check oil level in transmission, start engine and inspect pump and lines for leaks.

TRANSMISSION REPLACEMENT

NOTE: Coach should be placed on run-up blocks approximately 5 inches high. Access to transmission is gained by opening engine compartment doors and removing rear bumper extension. Dust pans - one below transmission and one below propeller shaft - must also be removed.

Since some of the operations required prior to removing transmissions depend on whether coach is equipped with 6- or 8-cylinder engine, the procedure for each type is covered separately below:

PRELIMINARY OPERATIONS

Vehicles With 6V-71 Engine (Wet Clutch)

1. Remove drain plug from flywheel housing and drain out oil.
2. Unhook clutch lever return spring and remove spring anchor bracket from transmission cover. Refer to figure 1.
3. Remove lock nut and clutch adjusting nut from clutch release rod.

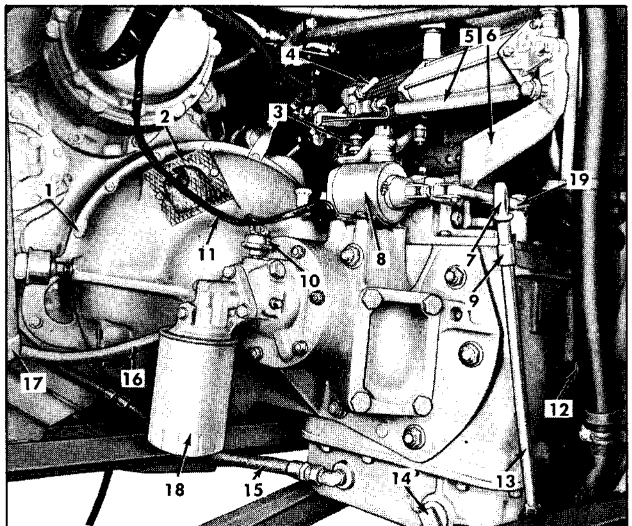
Vehicles With 8V-71 Engines (Dry Clutch)

1. Disconnect air line from clutch release air cylinder, then remove clutch lever spring and remove air cylinder assembly. Refer to CLUTCH (SEC. 5) in this manual for information regarding clutch release mechanism.
2. Remove air cylinder bracket which is bolted to transmission.
3. Remove lock nut and adjusting nut from clutch release rod. Also remove screen from inspection and ventilation opening in clutch housing.

REMOVING TRANSMISSION (Fig. 9)

NOTE: The following instructions are applicable to all coaches unless otherwise indicated.

1. Disconnect propeller shaft at transmission referring to PROPELLER SHAFT (SEC. 18) in this manual for necessary information. Also disconnect speedometer drive from transmission. If electric speedometer is used, disconnect wiring and remove sending unit from transmission.
2. Remove ground strap bolts from transmission case.
3. Disconnect transmission shift rods from levers at transmission cover. Remove 3rd and 4th shift lever from stud in cover. Removal of lever provides clearance for swinging transmission during removal. Tie or wire clutch release lever to transmission to prevent its falling toward engine during transmission removal.
4. Remove reverse solenoid shift lever from transmission.
5. Disconnect wiring from oil pressure switch and reverse solenoid.



1 Flywheel Housing Bolts and Washers	11 Wiring Harness
2 Cover (Screen)	12 Ground Straps
3 Transmission Shift Rod	13 Dip Stick Tube
4 Clutch Release Rod	14 Transmission Drain Plug
5 Clutch Lever Spring	15 Suction Line
6 Air Cylinder Bracket	16 Oil Supply Line
7 Dip Stick	17 Engine Oil Filter
8 Reverse Solenoid	18 Transmission Oil Filter
9 Tube Bracket	19 Reverse Lever
10 Oil Pressure Switch	

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Figure 9—Transmission Installed

6. Drain oil out of transmission and remove oil dipstick tube and elbow.
7. Disconnect fluid lines at pump on engine. Tie lines up to transmission.

SAFETY CAUTION

Before proceeding with step below, block coach body securely. When attaching hoist to take weight of transmission, the coach body may be inadvertantly raised just enough to cause height control valve to exhaust, in which case entire weight of rear end of coach will be placed on hoist.

8. Attach lifting tool (fig. 10) to transmission, and attach hoist to lifting eye. Remove clutch and flywheel housing bolts and washers (1), then lift transmission assembly and move straight away from engine until splines are disengaged. Turn the transmission as shown in figure 10 and remove from engine compartment.
9. On transmission with wet clutch, remove gasket used between clutch housing and flywheel housing.

TRANSMISSION (MECH.)

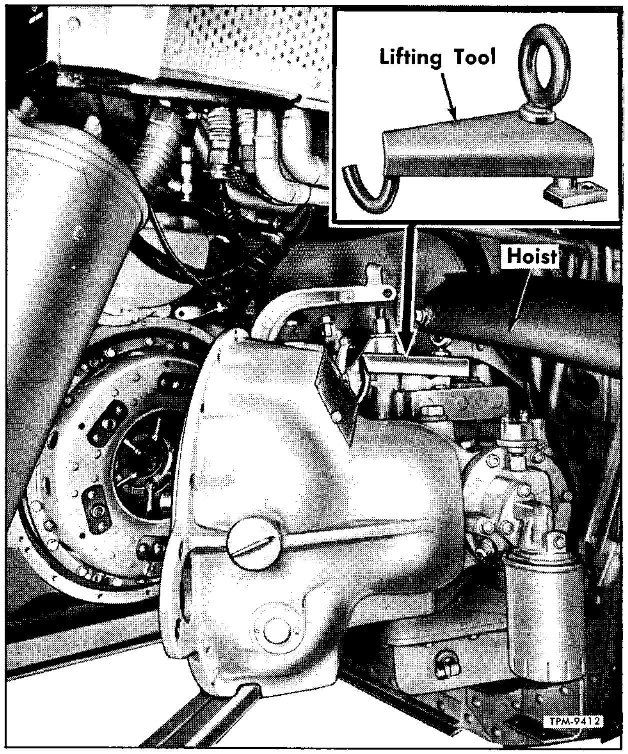


Figure 10—Replacing Transmission

INSTALLING TRANSMISSION (Fig. 10)

NOTE: Before installing transmission, condition of clutch parts should be carefully checked. Refer to CLUTCH (SEC. 5) for instructions in regard to inspection of clutch parts and setting of release levers (dry clutch only).

1. On transmission used with wet clutch, place new gasket at clutch housing flange. Use light coat of cement to hold gasket in place.
2. With clutch release parts assembled in clutch housing, lift transmission with hoist and lifting tool as shown in figure 10. Move transmission into engine compartment and guide splined shaft into position in line with clutch members, also enter clutch release rod through hole at upper end of release lever.
3. Carefully guide splined shaft through clutch members, and align bolt holes in clutch housing with corresponding holes in flywheel housing. Install bolts and washers from flywheel housing side using three long bolts and tubular spacers at original locations. Install balance of bolts and washers from clutch housing side of bolting flange.
4. Remove lifting tool and install transmission shift lever on stud at transmission cover.
5. Connect propeller shaft at yoke on transmission output shaft. Refer to PROPELLER SHAFT (SEC. 18) for information on construction and assembly procedure. Install bolts to attach ground straps to transmission case.
6. Connect fluid lines from transmission sump and from oil filter bracket to pump. Refer to figure 3.
7. Install dip stick tube elbow and tube as shown in figure 1. Connect speedometer drive at transmission. If electric sending unit is used, mount sending unit on transmission.
8. Install reverse shift lever and connect lever to solenoid link.
9. Connect shift rods to respective levers. Check transmission control linkage and adjust if necessary referring to "Control Rod Adjustment" covered previously in this section.
10. Connect electrical wiring at oil pressure switch, reverse solenoid, and electric speedometer sending unit (if used). Check the operation of reverse solenoid and adjust solenoid linkage if required, referring to "Reverse Solenoid and Linkage Adjustment" previously covered in this section.
11. Fill transmission with oil to level mark on dipstick. Refer to LUBRICATION (SEC. 13) of this manual, for correct type of lubricating oil to use and also for lubricant capacity of each type of transmission.

INSTALLING CLUTCH RELEASE MECHANISM (Vehicles With Dry Clutch)

1. Install air cylinder bracket on transmission, then install clutch release air cylinder and refer to CLUTCH (SEC. 5) of this manual, for instructions regarding clutch linkage adjustment.
2. Install screen on inspection and ventilation opening in clutch housing.

INSTALLING CLUTCH LEVER SPRING AND BRACKET (Vehicles With Wet Clutch)

1. Install adjusting nut and lock nut on clutch release rod. Adjust clutch release linkage, referring to pertinent instructions in CLUTCH (SEC. 5) of this manual.
2. Install clutch lever return spring anchor bracket on transmission cover, and hook up lever return spring.

NOTE: Before starting engine be sure drain plug in engine flywheel housing is in place and firmly tightened.

AFTER INSTALLATION INSPECTIONS

1. Start engine and inspect all connections and plugs for oil leaks.
2. Try operating transmission in each speed to check transmission shifting mechanism.
3. Check operation of clutch controls. Refer to CLUTCH (SEC. 5) of this manual, for instructions covering clutch adjustments.

NOTE: After operating transmission recheck oil level on dipstick and fill to level mark if necessary. Install dust pans and bumper extension when inspections have been completed.

TRANSMISSION OVERHAUL

REMOVING REVERSE SOLENOID AND TRANSMISSION COVER

1. Remove bolts which attach reverse solenoid and bracket.
2. On vehicles with electric speedometer, remove sending unit and drive cable assembly.

NOTE: On some transmissions the above operations may have been done in removing transmission from coach.

3. Remove bolts which attach cover assembly (6) to transmission case, then remove the cover assembly including shift levers and forks.
4. Remove cover gasket.

REMOVING CLUTCH HOUSING AND BEVEL DRIVE GEARS

Key numbers in text refer to figure 11 unless otherwise indicated.

1. Remove oil filter assembly (23) from mounting pad on bearing cap assembly (25).
2. Remove stud nuts and washers attaching bearing cap (25). Remove bearing cap assembly and gasket (18).
3. Referring to figure 12 shift the sliding clutches to lock mainshaft so it cannot be turned, then remove bearing retaining nut (20) from drive gear (21).
4. Using puller screws in tapped holes in flange on bearing retainer (17) pull retainer and bearing assembly (24) out of clutch housing (27). Remove and tag shims (16) so same shims can be installed at assembly.
5. Remove stud nuts and washers which hold clutch housing in place on transmission case (two of the nuts are at transmission case flange), then with lead hammer, jar clutch housing loose and remove from studs. Remove retainer seal (6) from groove in retainer (9), and remove clutch housing gasket.
6. Remove bearing spacer (15) and any shims which may be present. Tie spacer and shims (if used) together for use at assembly. Remove inner bearing assembly (13).
7. Remove bevel drive gear (12) from drive gear (21), pry key (7) out of slot in shaft, and remove spacer (8).

NOTE: Late production vehicles have two keys (items 7, fig. 11).

REMOVING OIL RESERVOIR

1. Remove stud nuts and washers which attach oil reservoir to transmission case. Remove reservoir and gasket.
2. Remove screws which hold screen to reservoir and remove screen.

REMOVING REVERSE IDLER GEAR

1. Remove reverse idler gear shaft lock at rear of transmission case.
2. Use puller in tapped hole in reverse idler gear shaft and pull shaft out of transmission case. Referring to figure 12 remove reverse gears, thrust washers and bearings.

REMOVING MAINSHAFT ASSEMBLY AND DRIVE GEAR

Key numbers in text refer to figure 13.

1. With sliding clutches shifted to lock transmission and prevent shafts from turning, remove nut (39) and washer (38) which retain yoke assembly (41) on mainshaft (36). Remove yoke assembly from mainshaft splines.
2. Remove stud nuts and washers which retain rear bearing cap (34), then remove bearing cap and gasket (33). Also remove countershaft bearing cap (53).
3. Remove cotter pin at countershaft nut (77), then remove nut (77). Bend lock (54) away from nuts (45 and 51) at rear end of countershaft. Remove these nuts.

The operations described in step 3 are not required in order to remove mainshaft and gears, but should be performed while both shafts are locked to facilitate loosening the countershaft nuts if countershaft is to be removed and disassembled.

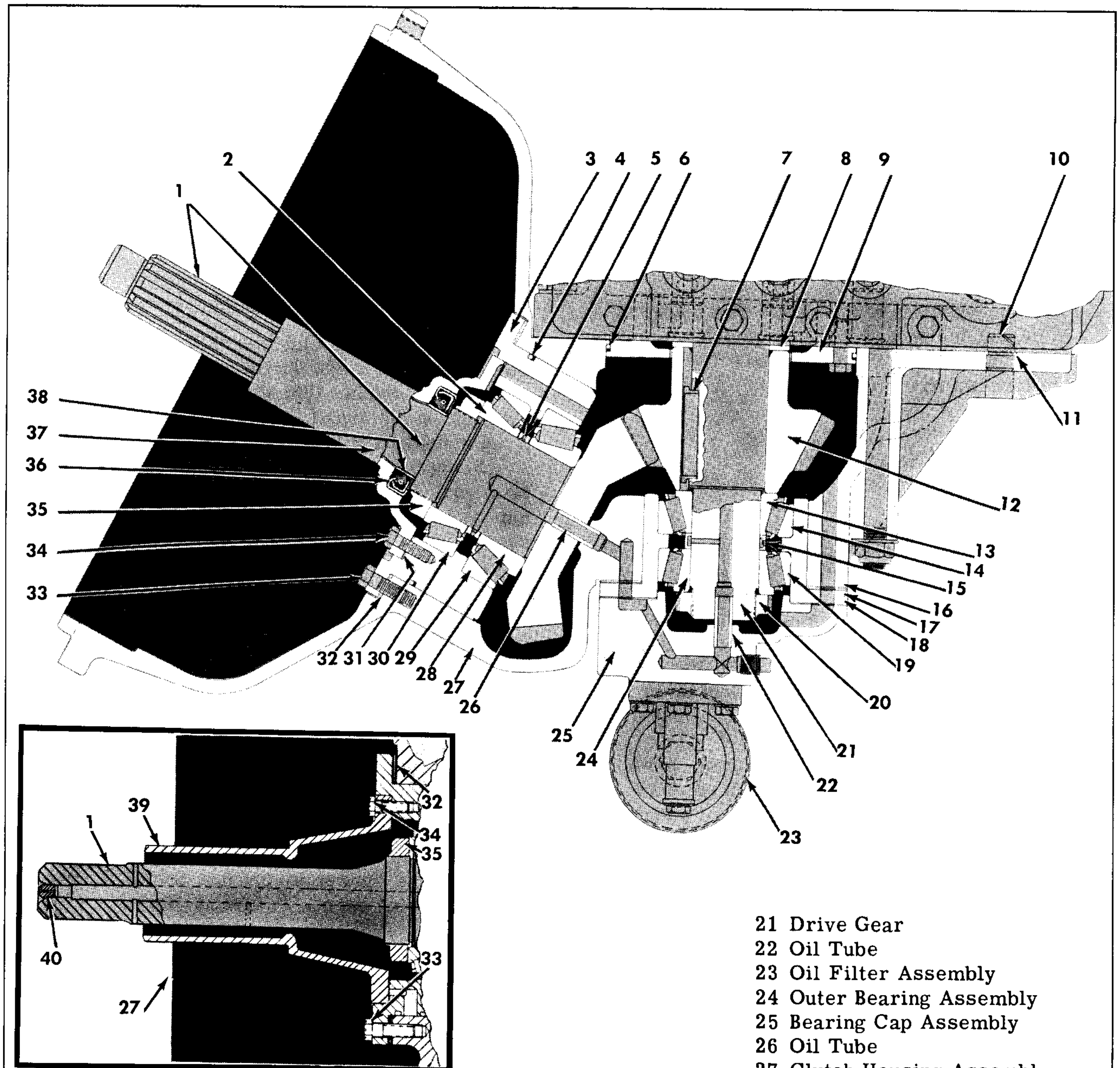
CAUTION: To avoid damage to countershaft rear bearing when removing nuts (51 and 45), use a short socket or partially fill cavity in deep socket with suitable spacer to prevent socket from contacting bearing cage.

4. At front of transmission remove bolts which attach bearing retainer (10), then use two 3/8-16 bolts in puller screw holes in retainer flange to pull retainer (10), bearing (12) and drive gear (15) out of transmission case. Remove mainshaft pilot bearing (14) from mainshaft.
5. Remove speedometer drive gear (31), then remove key (40) from mainshaft.
6. Use two 7/16-14 bolts in puller screw holes in flange on bearing retainer (44), to pull retainer and bearing (43) out of case. Remove retainer and bearing assembly from rear end of mainshaft, then tie mainshaft gears to hold them in place and lift the mainshaft and gear assembly out of transmission case.

REMOVING COUNTERSHAFT ASSEMBLY

1. With nuts (45 and 51) removed from rear end of countershaft (see step 3 in preceding operation) assemble puller to rear bearing retainer (55). Use two 7/16-14 bolts to attach puller to retainer.

TRANSMISSION (MECH.)



CONSTRUCTION WITH
WET TYPE CLUTCH

1 Drive Pinion
2 Outer Bearing Assembly
3 Bearing Retainer
4 O-Ring Seal
5 Bearing Spacer
6 Retainer Seal
7 Key (2 Used on Late Prod.)
8 Gear Spacer
9 Drive Gear Bearing Retainer
10 Dowel Pin
11 Dowel Pin Snap Ring
12 Bevel Drive Gear
13 Inner Bearing Assembly
14 Inner Bearing Cup
15 Bearing Spacer
16 Shims and Gaskets (See Text)
17 Bearing Retainer
18 Gasket
19 Outer Bearing Cup
20 Bearing Retaining Nut
21 Drive Gear
22 Oil Tube
23 Oil Filter Assembly
24 Outer Bearing Assembly
25 Bearing Cap Assembly
26 Oil Tube
27 Clutch Housing Assembly
28 Inner Bearing Assembly
29 Inner Bearing Cup
30 Outer Bearing Cup
31 Gasket
32 Shims
33 Bearing Retainer Bolt
34 Bearing Cap Bolt
35 Bearing Retaining Nut
36 Oil Seal
37 Bearing Cap (with Dry Clutch)
38 Oil Seal Sleeve
39 Bearing Cap (with Wet Clutch)
40 Restriction Fitting

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Figure 11—Cross Section At Transmission Bevel Gears

Tighten puller screw against rear end of countershaft to pull retainer out of case (69) and at the same time remove rear bearing (50) from countershaft.

2. Use arbor press to remove bearing (50) from retainer (55).

3. Remove countershaft 1st speed gear (49) and thrust washer (46) from rear end of countershaft, move countershaft assembly rearward, then raise front end of countershaft and remove the assembly from the transmission case.

DISASSEMBLY OF SUBASSEMBLIES

Key numbers in text refer to figure 13 unless otherwise indicated.

MAINSHAFT DISASSEMBLY

1. Untie gears and remove first speed gear (21) bearings (28) and spacers (29), first and second speed sliding clutch (27) and third and fourth speed clutch (79).

2. Raise tangs on lock (81) and remove nut (16) from end of mainshaft (36).

3. Remove clutch gear (80), then remove 3rd speed gear (18), bearings (23) and spacer (22). Remove thrust collar (24) from mainshaft, then remove 2nd speed gear (19), bearings (25) and spacer (26).

COUNTERSHAFT DISASSEMBLY

1. Remove low speed gear sliding clutch (48).

2. With front bearing nut (77) and washer (76) removed, remove front bearing inner race, and retaining washer (75). Bearing and outer race need not be removed unless bearing is to be replaced. In that event, use a suitable tool to remove bearing from retainer in transmission case.

4. Drive gear (68), and gear (66) may be pressed off countershaft separately. Keys (73) at front of countershaft must be removed before spacer (70) and gear (66) can be removed.

BEVEL GEAR AND BEARING DISASSEMBLY

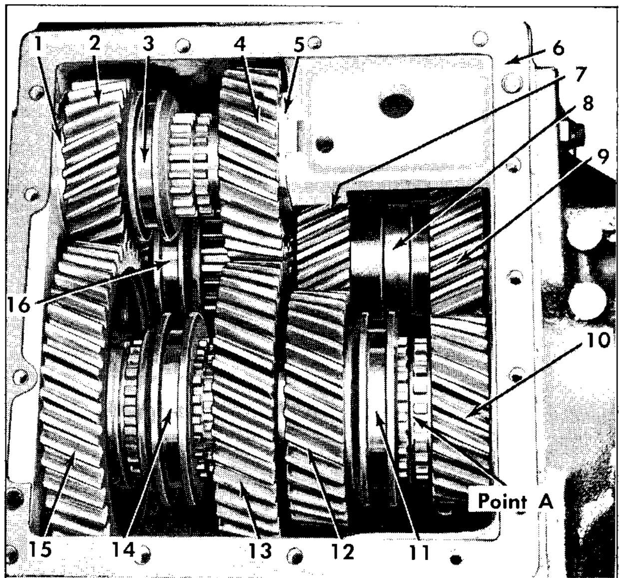
Key numbers in text refer to figure 11 unless otherwise indicated.

1. If clutch release bearing and operating parts are in clutch housing, refer to CLUTCH (SEC. 5) for instructions and remove clutch parts.

2. Remove bearing cap bolts (34), then use two puller screws in tapped holes (11, fig. 2) and remove bearing cap (37).

3. On transmissions with dry clutch, remove oil seal assembly from bearing cap.

4. Remove bearing retainer bolts (33), then using puller screws in tapped holes in retainer flange, force the bearing retainer (3) out of clutch housing. Drive pinion (1) and bearings will come out with the retainer. Remove O-ring seal (4) from



1 Rear Thrust Washer
2 Reverse Idler Driven Gear
3 Reverse Idler Sliding Clutch
4 Reverse Idler Drive Gear
5 Front Thrust Washer
6 Cover Gasket
7 Countershaft 3rd Speed Gear
8 Gear Spacer
9 Countershaft Drive Gear
10 Drive Gear
11 3rd and 4th Speed Sliding Clutch
12 Mainshaft 3rd Speed Gear
13 Mainshaft 2nd Speed Gear
14 1st and 2nd Speed Sliding Gear
15 Mainshaft 1st Speed Gear
16 Countershaft Sliding Clutch

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Figure 12—Transmission With Cover Removed

groove in retainer (3). Tag shims (32) so original pack may be used when reassembling.

4. Drive flat wedge under front edge of nut to raise staked portion of nut (35) out of slots in drive pinion (1), then remove bearing retaining nut. Use arbor press and press on front end of drive pinion (1) to remove pinion and inner bearing assembly (28) from retainer (3). Remove outer bearing assembly (2) from retainer and remove bearing spacer (5) and shims (when used) from pinion shaft. Tie spacer and shims together for use when assembling. Use suitable drift through holes in pinion gear to drive inner bearing assembly (28) off pinion shaft, when it is necessary to replace inner bearing assembly. Bearing cups (29 and 30) can be removed from retainer (3) if worn or damaged.

TRANSMISSION COVER AND SHIFT MECHANISM DISASSEMBLY

Key numbers in text refer to figure 15 unless otherwise indicated.

1. Referring to figure 2, remove levers from transmission cover. Outer fingers (3 and 8) are

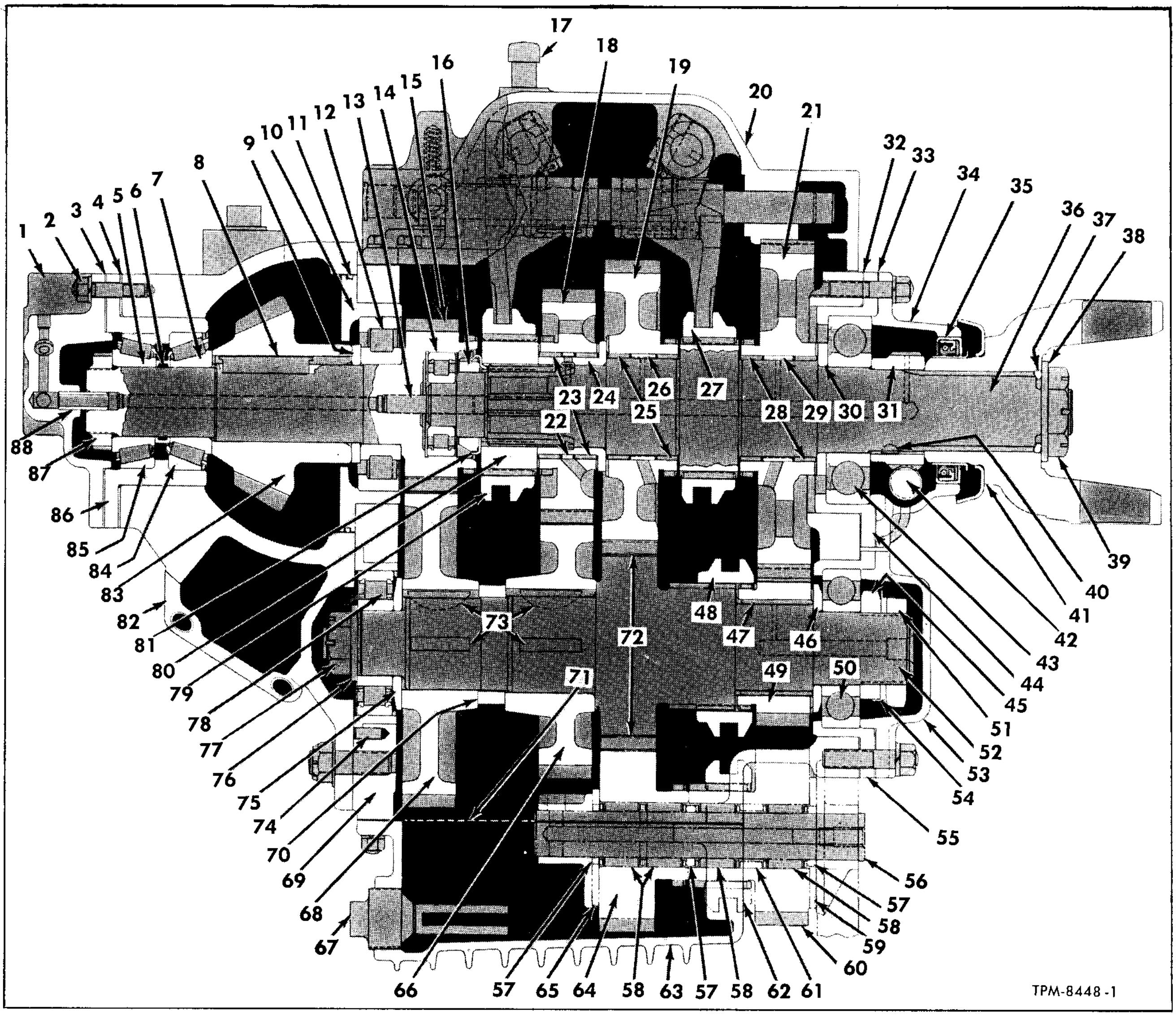


Figure 13—Cross Section of Transmission Assembly

held to respective shafts by clamp bolt and lock washer and are located by Woodruff keys.

2. Move all shift forks to neutral position and remove lock wires used to secure bolts (18).

3. Remove clamp bolts which hold 3rd and 4th shift fork (10) on rod (17). Drive rod (17) forward through fork and force hole plug out of cover. Remove rod (17), sleeve (5), and fork (10). Hold hand over hole in cover boss below poppet and catch poppet ball, plunger and spring as rod is removed from cover.

4. Remove two clamp bolts holding fork (1) on shift rod (16), then drive rod (16) forward out through cover in same manner as described in step 3 above. Use care not to lose poppet parts.

5. Remove two clamp bolts holding reverse shift fork (13) to shift rod (15). Drive rod (15) forward and remove in same manner as previously described for removing rods (16 and 17). Remove threaded plug from side of cover, then remove two shift rod interlocks.

6. At outer side of cover, remove reverse lever collar from shift finger shaft (4). Remove clamp bolt from 1st, 2nd, and reverse inner finger (12), move finger to expose Woodruff key, and remove key. Pull shaft (4) out of cover and remove washer, spring (11) and inner finger (12) from inside cover.

7. Remove clamp bolt from inner finger (7), move finger to expose Woodruff key and remove key. Remove shift finger shaft from cover, and remove inner finger (7) and washer (8) from inside cover. If finger shaft oil seals require replacement, drive old seals out of transmission cover.

1 Bearing Cap Assembly	31 Speedometer Drive Gear	61 Bearing Spacer (Long)
2 Stud Nut	32 Retainer Gasket	62 Reverse Idler Sliding Clutch
3 Gasket	33 Cap Gasket	63 Transmission Oil Reservoir
4 Shims (See Text)	34 Rear Bearing Cap	64 Reverse Idler Gear
5 Outer Bearing Assembly	35 Oil Seal	65 Thrust Washer
6 Bearing Spacer	36 Mainshaft	66 Countershaft 3rd Speed Gear
7 Inner Bearing Assembly	37 Seal	67 Drain Plug
8 Key	38 Washer	68 Countershaft Drive Gear
9 Gear Spacer	39 Yoke Nut	69 Transmission Case
10 Drive Gear Bearing Retainer	40 Key	70 Spacer
11 Retainer Seal	41 Yoke Assembly	71 Screen
12 Drive Gear Rear Bearing	42 Speedometer Driven Gear	72 2nd Speed Gear Teeth (Integral with Countershaft)
13 Oil Tube	43 Mainshaft Rear Bearing	73 Gear Keys
14 Mainshaft Pilot Bearing	44 Bearing Retainer	74 Dowel Pin
15 Drive Gear	45 Inner Lock Nut	75 Gear Retaining Washer
16 Mainshaft Nut	46 Thrust Washer	76 Bearing Retaining Washer
17 Breather	47 Bushing	77 Countershaft Nut
18 3rd Speed Gear	48 Countershaft Sliding Clutch	78 Countershaft Front Bearing
19 2nd Speed Gear	49 Countershaft 1st Speed Gear	79 3rd and 4th Speed Sliding Clutch
20 Transmission Cover	50 Countershaft Rear Bearing	80 Mainshaft Clutch Gear
21 1st Speed Gear	51 Outer Nut	81 Lock
22 Bearing Spacer	52 Countershaft	82 Clutch Housing
23 3rd Speed Gear Bearings	53 Bearing Cap	83 Bevel Drive Gear
24 3rd and 4th Speed Gear Thrust Collar	54 Nut Lock	84 Inner Bearing Cup
25 2nd Speed Gear Bearings	55 Bearing Retainer	85 Outer Bearing Cup
26 Bearing Spacer	56 Reverse Idler Shaft	86 Bearing Retainer
27 Sliding Clutch	57 Bearing Spacer (Short)	87 Bearing Retaining Nut
28 1st Speed Gear Bearings	58 Roller Bearing Assembly	88 Oil Tube
29 Bearing Spacer	59 Thrust Washer	
30 Thrust Washer	60 Reverse Idler Driven Gear	

Captions For Figures 13 and 14

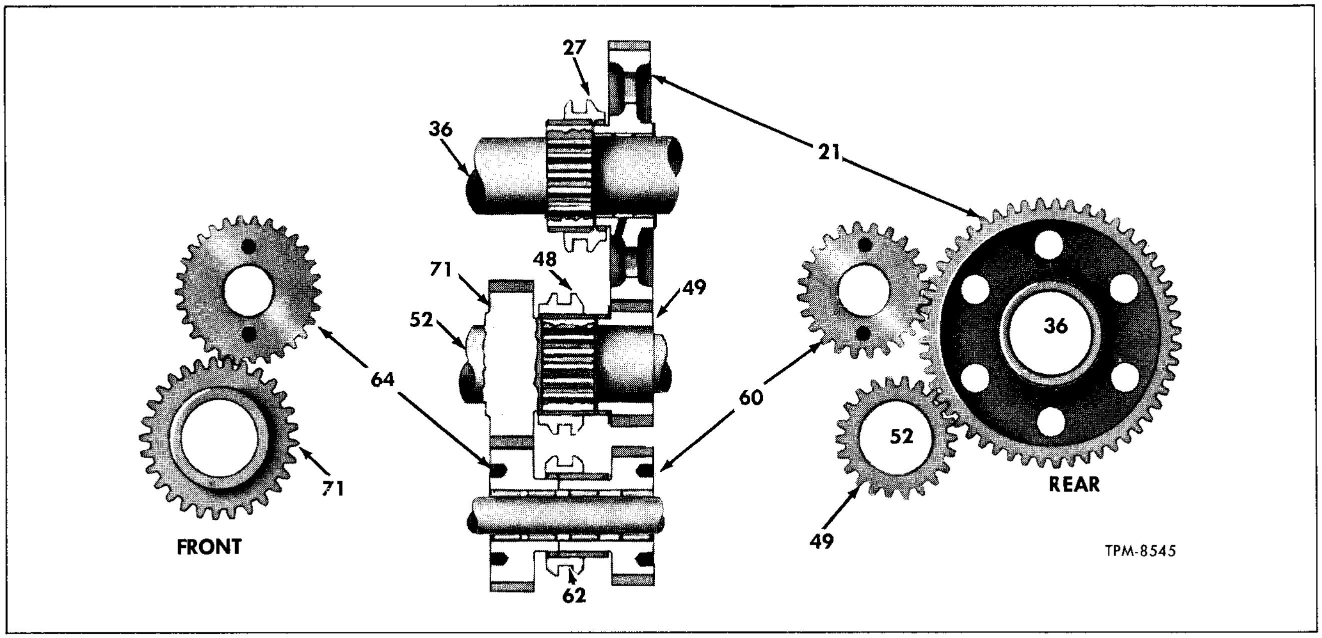


Figure 14—Position of Gears For Reverse Operation

CLEANING AND INSPECTION

Clean all parts carefully in suitable cleaning fluid and blow dry with compressed air.

All bearings should be cleaned thoroughly. After bearing assemblies have been soaked in cleaning fluid, tap them sharply on a block of wood to dislodge any solid particles. Slush them again in cleaning fluid and blow dry with air. Do not spin the bearings with the air - revolve them slowly in races with fingers as air is directed at right angles to the balls or rollers. Examine races and bearings for pits and scores, then oil each assembly thoroughly with clean engine oil.

Individual needle bearing rollers which were removed from main shaft gears should be thoroughly washed and inspected. Replace those bearing rollers which show signs of scores or pits. (There are 138 rollers to each gear.)

Examine teeth on all gears carefully for nicks and worn spots. Do not take chances with gears which are appreciably nicked or scored. Small nicks may be carefully removed with a "slipstone" or hone.

Inspect wear sleeve on propeller shaft yoke and sleeve on drive pinion which are contacted by oil seal lips. If sleeves are worn, replace with new parts.

Clean interior of main case and covers thoroughly. Remove magnetic drain plug and clean all particles of metal from magnet and remove all dirt from screen. Blow out all oil passages with compressed air.

Inspect faces on shift forks which contact respective sliding clutches. If forks or sliding clutches are worn or scored replace parts as necessary.

ASSEMBLY OF SUBASSEMBLIES

Key numbers in text refer to figure 13 except as otherwise indicated.

COUNTERSHAFT ASSEMBLY (Fig. 13)

1. Press third speed countershaft gear (66) onto shaft with long hub of gear toward front. Make certain that both keys (73) are in position and keyways are free from burrs.
2. Place spacer (70) and keys (73) in position and press drive gear (68) onto shaft with long hub of gear toward rear.
3. Install drive gear retaining washer (75) with recessed edge toward bearing (78).
4. Install front bearing inner race, retaining washer (76) and nut (77). Tighten nut to 300 to 350 foot-pounds and install cotter pin.
5. Install front bearing (78) in case if it has been removed.
6. Install sliding clutch (48) over countershaft clutch gear with long hub toward front. Do not install first speed gear (49) at this time.

MAINSHAFT AND DRIVE GEAR ASSEMBLY (Fig. 13)

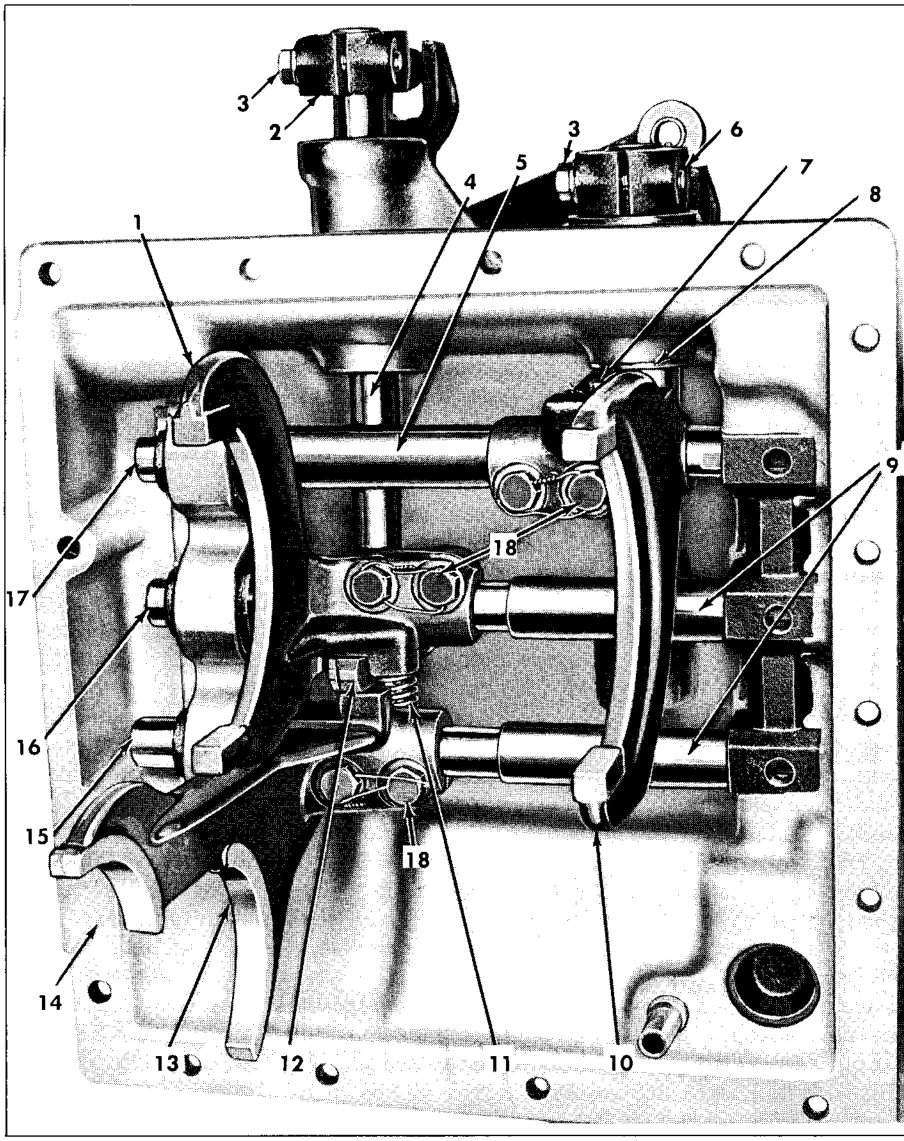
1. Place mainshaft (36) in vise with rear end of shaft down (vise should be equipped with "soft" jaws).
2. Make sure second speed gear (19) is clean, especially on inside diameter, then apply a coat of heavy gear oil. Place gear over mainshaft with gear clutch teeth toward rear.
3. Install 69 roller bearings (25) in hub of gear. Install bearing spacer (26) and push bearings and spacer in position. Then install another row of roller bearings.
4. Install third speed gear thrust collar (24) with oil hole indexed with oil hole in shaft. Install third speed gear (18) and bearings (23) in same manner as second speed gear, except that gear clutch teeth are toward front.
5. Install third and fourth speed clutch gear (80) over splines of mainshaft with chamfered end of splines toward rear. Install sliding clutch (79) over gear (80) with extended edge of gear toward rear.
6. Install lock (81) and retaining nut (16) and tighten nut firmly. Bend lock over flat of nut (16). Install pilot bearing (14) on mainshaft pilot.
7. Position mainshaft with rear end upward, then install sliding clutch (27) with extended edge toward rear (upper) end of mainshaft. Place 1st speed gear (21) on mainshaft with clutch teeth toward sliding clutch (27). Install 1st speed gear bearings (28) and bearing spacer (29) in same manner as described previously for installing second and third speed gears (18 and 19).
8. Coat inner face of thrust washer (30) with grease and place in position. Grease will prevent washer from sliding out of place when assembly is lowered into case and in that manner prevent bearings from falling out when shaft is tilted for installation. It is also a good practice to temporarily wire gears (18, 19, and 21) together to hold them in place while installing shaft assembly.
9. Press outer race of bearing (12) into drive gear bearing retainer (10) and press inner race and roller assembly onto drive gear (15). Install gear spacer (9), and drive gear key (8) into slot in shaft.

NOTE: Assembly and adjustment of inner and outer tapered bearings (7 and 5) is accomplished during transmission build-up and is covered later in this section under "Assembly of Transmission."

DRIVE PINION AND BEARINGS ASSEMBLY

Key numbers in text refer to figure 11.

1. Press inner bearing assembly (28) into place on pinion (1).



1 1st and 2nd Shift Fork
2 Shaft Outer Finger
3 Clamp Bolt
4 1st, 2nd and Reverse Shift Finger Shaft
5 Shift Rod Stop Sleeve
6 Outer Finger
7 Inner Finger
8 Shaft Washer
9 Shift Rod Stop Sleeves
10 3rd and 4th Shift Fork
11 Shift Shaft Spring
12 1st, 2nd and Reverse Inner Finger
13 Reverse Shift Fork
14 Cover
15 Reverse Shift Rod
16 1st and 2nd Shift Rod
17 3rd and 4th Shift Rod
18 Fork Bolts

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Figure 15—Transmission Cover With Forks and Shifting Mechanism

2. Install cups (29 and 30) in bearing retainer (3) if cups have been removed.

3. If original retainer and bearings are being used, install bearing spacer (5) and shims which were removed at disassembly. If new bearings and/or retainer are being installed, select service spacer (5) (0.395" thick, #2419741) and service shims to provide a total thickness of 0.439 inches. Shims are furnished in following thicknesses: .003", .005", .010", and .020". Set pinion on bench with splines upward and lower the retainer (3) over pinion shaft (1) and into position at inner bearing (28). Position outer bearing (2) at pinion shaft and drive or press bearing into contact with spacer (5).

4. Install bearing retaining nut (35) and tighten to 500 foot-pounds torque; then measure endwise movement of pinion with respect to bearings. Make note of endwise movement and remove bearing nut, outer bearing assembly, spacer and shims.

5. Determine correct shim pack to use as follows:

Add 0.001 inch to the end play noted in step 4 above, then subtract this sum from the 0.439 inch dimension specified in step 3 above. The result is the correct total thickness for shims and spacer to provide proper bearing pre-load.

6. Select the combination of shims and spacer (5) to give total thickness specified above, and reassemble spacer, shims, outer bearing (2), and nut (35). Tighten nut to 500 foot-pounds.

7. Preload on pinion bearings should be 5 to 15 inch-pounds when bearing nut is tightened. Preload may be determined without a special torque measuring devise by using a spring scale on a

string wrapped around the stem end of pinion. The force required on string to rotate pinion is from 5.5 to 17 pounds for proper pre-load.

If pull required to rotate pinion is not 5.5 to 17 pounds, the shim pack must be changed as necessary to provide correct pre-load. A change of 0.001 inch in shim pack will change the torque required to rotate pinion shaft by 7 inch-pounds.

8. When bearing adjustment is completed, stake the bearing retaining nut at slots in pinion to lock the nut.

9. On transmission used with dry clutch, coat outer circumference of new bearing cap oil seal with sealer, then install seal in counterbore in cap with seal lip pointing toward transmission side of cap as shown in figure 11.

ASSEMBLING TRANSMISSION COVER COMPONENTS

Key numbers in text refer to figure 15 unless otherwise specified.

1. Install 1st, 2nd, and reverse shift finger shaft (4) in cover, assembling flat washer, spring (11) and inner finger (12) as shaft is installed. Install finger key in shaft, then locate finger so clamp bolt will engage notch in shaft, and install clamp bolt in finger (12). Secure clamp bolt with lock wire. If shaft oil seals - one at each side of transmission cover - have been removed, drive new seals into place in cover with seal lips pointing inward. Install outer lever (2) on outer end of shaft (4) using Woodruff key and clamp bolt (3) with lock washer.

2. Install 3rd and 4th shift finger shaft in cover, assembling washer (8) and inner finger (7) on shaft as it is moved into place. Install Woodruff key in slot, locate inner finger (7) on shaft, and install clamp bolt. Secure clamp bolt with lock wire. Install shaft oil seal at outer side of cover if seal has been removed, then install outer finger (6) on outer end of shaft using key and clamp bolt (3) with lock washer.

3. Position cover assembly up-side-down, then drop 3rd and 4th shift rod poppet spring, plunger, and ball through hole in shift rod boss. Hold poppet ball down and insert 3rd and 4th shift rod (17) through hole in front of cover. When end of shift rod is through front support, hold shift fork (10) in cover and push shift rod through fork. Assemble stop sleeve (5) on rod, and move rod into position in cover. Notches in shift rod must be aligned with clamp bolt holes in fork (10) and inner finger (7) must engage notch in shift rod lug. Install two clamp bolts (18), tighten bolts firmly and secure with lock wire.

4. Place one interlock in hole between rods (16 and 17). Install spring, plunger, and poppet ball in center poppet hole, then install 1st and 2nd shift rod (16), stop sleeve (9), and shift fork (1) in position shown in figure 15. Inner finger (12) must engage notch in lug on fork (1). Install and tighten two fork clamp bolts (18) and secure with lock wire.

5. Place one interlock between rods (15 and 16) and move rods (16 and 17) to neutral position (poppet ball engaging center notch), then install spring, plunger, and poppet ball in poppet hole at reverse shift rod. Install reverse shift rod (15) assembling stop sleeve (9) and shift fork (13) on rod as it is moved into place. Install and tighten two clamp bolts (18) and secure with lock wire.

6. Install three shift rod hole plugs at front of cover and install threaded hole plug at side of cover.

7. Referring to figure 2 install shift levers on transmission cover, with lever yokes engaging outer fingers as shown.

ASSEMBLY OF TRANSMISSION

Apply transmission oil on transmission parts to provide initial lubrication and prevent rusting.

TRANSMISSION MAIN CASE BUILD-UP

Key numbers in text refer to figure 13 unless otherwise indicated.

COUNTERSHAFT INSTALLATION

1. Place countershaft and gear assembly into case, tilt front end upward and lower rear end into case, inserting rear end through rear bearing hole in case far enough to permit front end to be inserted into front bearing (78).

2. Install first speed gear (49) on countershaft by inserting gear through rear bearing hole in case.

3. Install thrust washer (46), recessed edge toward bearing (50).

4. Press rear bearing (50) into retainer (55). Place retainer gasket on studs at transmission case. Be sure retainer dowel pin is in place, then install bearing and retainer, being careful to align notch in retainer with dowel pin in case.

5. Install inner lock nut (45) and tighten to 300 to 350 foot-pounds.

6. Install nut lock (54) and outer nut (51). Tighten nut and lock both nuts by bending lips of washer over flats of nuts.

NOTE: Steps 5, and 6 above may be deferred until after mainshaft has been installed, at which time the gears can be locked to prevent shafts from turning when tightening nuts.

REVERSE IDLER GEAR INSTALLATION

Refer to figure 13 and note position and width of spacers installed, at ends and in between roller

bearings. Make sure that oil passages in shaft are clean and that plug in end of shaft is in place. Install reverse idler shaft in following manner:

1. Drive shaft into case just far enough to install thrust washer (59), driven gear, bearings (58) and spacers (57 and 61).
2. As shaft is driven into case, install remaining parts. Front thrust washer fits in notch in case as shown in figure 12.
3. After shaft is driven into case, flat on outer end of shaft must be in vertical position.
4. Install lock plate at rear of transmission case to hold reverse idler shaft in position.

MAINSHAFT AND MAIN DRIVE GEAR INSTALLATION

1. Tilt front end of mainshaft and gears assembly upward and lower rear end into transmission case and out through bearing retainer hole in case.
2. Fit drive gear (15) onto pilot bearing (14) on end of mainshaft assembly, then install retainer (10) and outer race of bearing (12) over end of drive gear and start retainer bolts into transmission case. Do not tighten retainer bolts until mainshaft rear bearing and retainer (44) have been installed.
3. Place retainer gasket (32) on studs in transmission case. Press bearing assembly (43) into retainer (44) with loading slots in races toward rear. Install the bearing and retainer assembly over rear end of mainshaft. Fit rear bearing retainer (44) over studs, and force inner race of bearing (43) into contact with thrust washer (30).
4. Install key (40) in slot in mainshaft, and install speedometer drive gear (31). Check for indexing of oil hole in speedometer gear with oil hole in mainshaft.
5. With oil seal (35) installed in mainshaft rear bearing cap (34) install bearing cap using new gasket (33). Install nuts and lock washers on bearing cap and retainer studs and tighten firmly. Install speedometer driven gear (42) and sleeve.
6. Install yoke assembly (41) on mainshaft splines, install O-ring seal (37) in recess in yoke, then install washer (38) and nut (39).
7. At front of transmission case tighten drive gear bearing retainer bolts, then shift sliding clutches to lock transmission shafts. Tighten yoke nut (39) to 500 to 550 foot-pounds. Install cotter pin to secure nut (39). If countershaft bearing nuts (45 and 51) have not been tightened, tighten inner nut (45), install lock (54). Install and tighten outer nut (51), then bend lock to prevent nuts from loosening. Also tighten countershaft nut (77).

CAUTION: There is danger of damaging countershaft rear bearing if too deep a socket is used in tightening nuts (45 and 51). If necessary install spacer in socket so edge of socket will not contact bearing (50).

8. Install countershaft rear bearing cap (53) using new bearing cap gasket. Tighten bearing cap and retainer stud nuts firmly.
9. If oil reservoir (63) is removed from transmission, attach screen (71) with three screws, then install reservoir on transmission case using a new gasket.

CLUTCH HOUSING AND ANGLE DRIVE GEAR INSTALLATION

NOTE: If it should be necessary to replace clutch housing or transmission main case, remove two dowel pins (10, fig. 11), then bolt clutch housing to transmission case. Drive gear bearing retainer (9) will serve to properly align housing with case. Drill and line ream dowel pin holes to accommodate oversize dowel pins. Separate the parts and install oversize dowel pins in transmission case. Provide counterbores in clutch housing to accommodate snap rings.

Procedure following includes instructions for installing clutch housing, bevel drive gears, and procedure for setting gears for proper tooth contact.

Key numbers in text refer to figure 11 unless otherwise indicated.

<u>Adjusting Bevel Drive Gear Bearing Pre-Load</u>

1. Install bevel drive gear (12) on drive gear (21).
2. Place O-ring seal (6) in groove in bearing retainer (9) and place clutch housing gasket at transmission case; then install clutch housing on studs and into contact with gasket. Install flat washers and stud nuts on clutch housing-to-transmission studs. Tighten stud nuts evenly and firmly. Stud nuts are self-locking type. Two studs are in clutch housing and nuts are installed at flange on transmission case.
3. Install inner bearing assembly (13), so bearing cone contacts solidly at gear. Place spacer (15) (0.394" thick, #2419742) and a combination of shims to provide total thickness of 0.433 inch on drive gear (21). With inner and outer bearing cups (14 and 19) in place in bearing retainer, assemble retainer to clutch housing using original shims (16) between retainer and housing. Use suitable spacers and nuts on studs to hold retainer firmly to housing.
4. Install outer bearing assembly (24) and nut (20) on drive gear (21) and tighten nut (20) to 300 to 350 foot-pounds torque.
5. Mount dial indicator on retainer stud and check amount of end play in drive gear (21).
6. Shift sliding clutches to neutral and check torque required to rotate drive gear. This can be done with spring scale and string wrapped around

nut (20). This rotating torque (without bearing pre-load) must be known in order to compute the amount of pre-load after changing shims as instructed in step 8 following:

7. Remove nut (20), outer bearing assembly (24), and spacer (15) and shims.

8. Determine correct shim pack to use as follows:

Add 0.002 inch to the amount of end play found in step 5 previously; then subtract this sum from the 0.433 inch dimension specified in step 2. previously. The result is the correct total thickness of spacer and shims to use to produce required bearing preload of 5 to 15 inch-pounds.

9. Select the combination of shims and spacer (15) to given total thickness specified above, then reassemble spacer (15), shims, outer bearing assembly (24), and nut (20). Tighten nut to 400 foot-pounds.

10. Determine drive gear bearing pre-load using spring scale and string wrapped around nut (20). Pre-load on bearings will be total pull required above minus the pull required to rotate drive gear (step 5). This result will be from 3.5 to 11 pounds if bearing pre-load is correct.

NOTE: The bevel pinion (1) should not be assembled to clutch housing while making the foregoing check.

If proper pre-load is not obtained, a change in spacer or shim pack thickness is necessary. Changing the shim pack 0.001 inch will result in a change of 3 inch-pounds pre-load.

11. Stake bearing retaining nut (20) when proper pre-load is obtained. After bearings are properly adjusted, proceed to install bevel pinion and bearing assembly and set up gears for correct tooth contact and backlash.

INSTALLING BEVEL PINION AND BEARING ASSEMBLY

Key numbers in text refer to figure 11.

1. Install O-ring seal (4) in groove in bearing retainer (3).

2. Locate original shims (32) at flange of retainer (3), then install bevel pinion and bearing assembly in clutch housing and install bearing retainer bolts (33). With transmission in neutral, try turning bevel pinion (1) as bolts (33) are tightened. If any binding is noted it may be due to insufficient backlash between bevel gears (1 and 12). Backlash can be increased by adding shims (32) at retainer flange and backlash must be from 0.006 to 0.012 inch.

3. Check bevel gear backlash with dial indicator. Mount a C-clamp on bevel pinion shaft and mount dial indicator on clutch housing. Set stem of indicator at a point on clamp 2-1/8 inches from surface of pinion shaft. Note on indicator dial the amount shaft can be rotated without moving bevel gear (12).

NOTE: When necessary to change backlash, a change of 0.002 inch in shim pack will change backlash 0.001 inch.

4. <u>Check Gear Tooth Contact.</u> NOTE: The outside shims (gaskets) in shim pack (16, fig. 11) are aluminum. These should be replaced with new parts when assembling transmission. Remove square head filler plug at top of housing above bevel gears. Use a stiff brush and apply a thin even coat of red lead on bevel gear teeth. Rotate bevel pinion shaft in same direction as in normal operation, while applying tension at propeller shaft flange. After rotating gears to produce a clear contact impression at drive side of bevel gear teeth (fig. 16), observe contact area through filler plug hole. Use flashlight to illuminate gears.

a. Tooth contact impression should start at toe of tooth and extend back about 80% of tooth length toward heel on drive side of tooth. Contact should be distributed evenly over flank of tooth indicating center of contact below pitch line. Refer to diagrams "A" and "B" in figure 16.

b. If tooth contact is short and too far out on heel of tooth (diagram "C" figure 16), increase thickness of shims (16) between bearing retainer (17) and housing (27), moving gear (12) toward pinion (1). Restore backlash by increasing shims (32) between bearing retainer (3) and housing (27).

CAUTION: When necessary to add shims (16) between retainer (17) and housing, it is important to measure space at point "A" (fig. 12) to determine if drive gear (21) is being pulled too far forward. If space between drive gear and clutch gear (15 and 80, fig. 13) exceeds 0.170 inch, there is danger of rollers in bearing (12, fig. 13) riding against shoulder in bearing outer race. To correct this condition a thicker spacer (9, fig. 13) must be used.

c. If tooth contact extends back from toe appreciably less than 80% of tooth length (diagram "D" fig. 16), move gear (12) away from pinion (1) by decreasing shims (16). Restore backlash by decreasing shims (32).

d. If contact is low on flank of tooth (see diagram "E" fig. 16), move pinion (1) away from gear (12) by increasing shims (32). Restore backlash by increasing shims (16).

e. If contact is high on face of tooth (diagram "F" fig. 16), move pinion (1) toward gear (12) by decreasing shims (32). Restore backlash by decreasing shims (16).

5. After tooth contact and backlash have been adjusted, install bearing cap assembly (25) using new gasket (18). Install oil filter assembly (23) using new gasket.

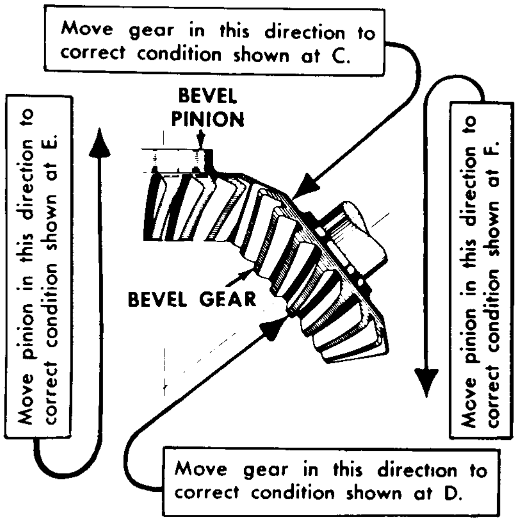
INSTRUCTIONS

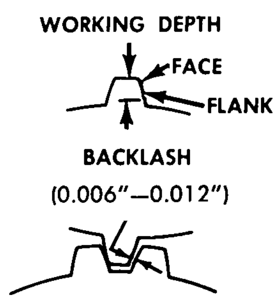
1—Install bevel pinion and bevel gear assemblies; then adjust pinion and bevel gear for proper backlash as directed in "Bevel Gear and Pinion Adjustments" paragraph of this section.

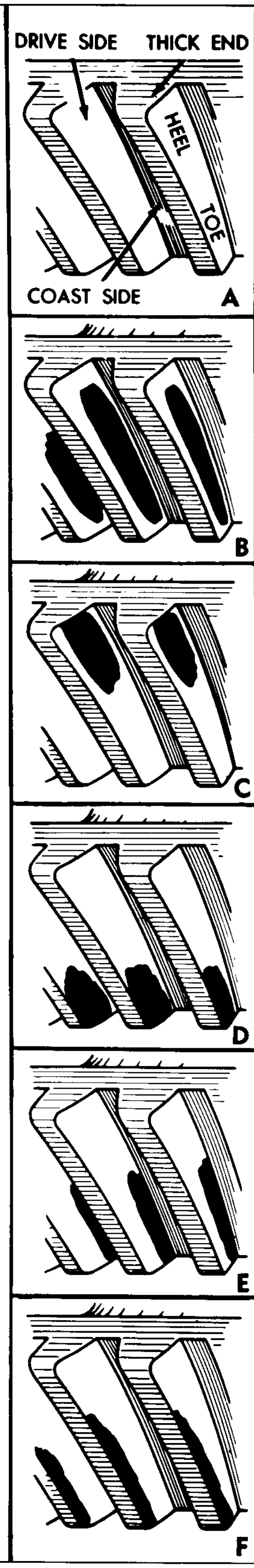
2—Paint three or four teeth of bevel gear with red lead or mechanics blue and rotate bevel gear in direction of rotation until pinion makes complete revolution.

3—Note area of tooth contact which should start at toe and extend abou 80 percent of tooth length toward heel, as at B.

4—Vary position of pinion and gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that gear can be completely revolved without any highspots being felt.







A—Check tooth Contact Pattern at drive side of BEVEL GEAR tooth

B—Shows correct tooth contact

NOTE: Key Numbers Below Refer to Figure 11

C—Shows short contact at heel. To correct, increase thickness of shims (16) to move gear toward pinion. Then increase thickness of shims (32) to move pinion away from gear to again secure correct backlash.

D—Shows short contact at toe. To correct, decrease thickness of shims (16) to move gear away from pinion. Then decrease shim thickness (32) to secure correct backlash.

E—Shows heavy contact on flank or lower portion of tooth. To correct, increase thickness of shims (32) to move pinion away from gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then increase thickness of shim (16) to move gear toward pinion to secure correct backlash.

F—Shows heavy contact on face or upper portion of tooth. To correct, decrease thickness of shims (32) to move pinion toward gear until contact covers flank of tooth without breaking contact at face. Then decrease thickness of shims (16) to move gear away from pinion to secure correct backlash.

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Figure 16—Gear Tooth Contact Chart

TRANSMISSION (MECH.)

TRANSMISSION CONTROL
COVER INSTALLATION

1. Move the four sliding clutches (3, 11, 4 and 16, fig. 12) to neutral position and locate new cover gasket on transmission case.

2. Shift all forks in cover (fig. 15) to neutral position, then carefully lower the cover assembly into place with forks entering grooves in respective sliding clutches.

3. Install cover bolts and lock washers.

4. Mount reverse solenoid and solenoid lever as shown in figure 6, and adjust solenoid linkage as previously directed under "Maintenance."

5. On vehicles with electric type speedometer sending unit, mount sending unit on transmission and connect flexible drive shaft between adapter at transmission rear bearing cap and sending unit.

NOTE: If transmission is to be installed immediately, steps 4. and 5. above should be deferred until transmission is installed in coach. Unless the power plant and cradle are out of vehicle, there will be interference if reverse solenoid and lever are mounted on transmission.

SPECIFICATIONS

GENERAL DATA

Make	Spicer
Model	7145V
Speeds	Four Forward—One Reverse
Mounting	On Power Plant
Gear Selection	Manual, Remote Control

GEAR RATIOS

Spicer Model*	7145V	7141VA	7141VC	7141VD
Angle Drive Gears	1 to 1	1 to 1	.808 to 1	.808 to 1
First Speed	4.36 to 1	3.86 to 1	3.12 to 1	3.96 to 1
Second Speed	2.84 to 1	2.50 to 1	2.02 to 1	2.29 to 1
Third Speed	1.70 to 1	1.50 to 1	1.21 to 1	1.37 to 1
Fourth Speed	1 to 1	1 to 1	.808 to 1	.808 to 1
Reverse	3.72 to 1	3.29 to 1	2.66 to 1	3.35 to 1

*Refer to name plate attached to transmission case for model number and part number.

GEAR BACKLASH

Angle Drive Gears	0.006"-0.012"
Mainshaft and Countershaft Gears	0.006"-0.011"
Sliding Clutches and Clutch Gears	0.004"-0.007"

MAINSHAFT GEAR BEARING ROLLERS

Number of rollers per gear	138
Length	0.655"-0.675"
Lapped Diameter	0.12500"-0.12525"

BEARING ADJUSTMENTS

Bevel Drive Gear Tapered Bearing
See Instructions in Text.

BEARING SPACER THICKNESS (Service)

Bevel Pinion Bearings	0.395"
Drive Gear Bearings	0.394"

BEARING ADJUSTING SHIMS

Sizes Available (Thickness)	0.003", 0.005", 0.010" and 0.020"
Bearing Preload (Rotating Torque)	
Bevel Pinion Bearings	5 to 15 in. lbs.
Bevel Drive Gear Bearings	5 to 15 in. lbs.

BEARING RETAINER SHIMS (for Adjusting Gear tooth contact)

Sizes Available (Thickness)	
Bevel Pinion Gear Bearing Retainer	0.003", 0.005", 0.010", 0.030"
Drive Gear Outer Bearing Retainer	0.003", 0.005", 0.010", 0.030"

BEARING RETAINER SHIMS (Cont.)

Average Thickness of Bearing Retainer Shim Pack	
(at Bevel Pinion)	0.066"
(at Bevel Gear)	0.066"
Necessary Space at Point "A" (Fig. 12) See text.	
Minimum	0.060"
Maximum	0.170"
Thrust Washer Thickness	
Reverse Gear	
Front	0.182"-0.187"
Rear	0.185"-0.187"
Countershaft 1st. Speed Gear	0.245"-0.249"
Mainshaft 1st. Speed Gear	0.262"-0.266"

COUNTERSHAFT 1ST SPEED GEAR BUSHING

Inside Diameter (As Serviced)	2.3460"-2.3490"
Inside Diameter (In Place)	
Grind to	2.3595"-2.3605"

TRANSMISSION OIL PUMP

Make	John S. Barnes Corp.
Type	Positive Displacement (Gears)
Capacity (At Zero psi, 400 Eng. rpm)	1 qt. in 10 to 12 sec.
Operating Pressure (Max.)	50 psi
Test Pressure	
Cold	20-60 psi
Hot	10-20 psi
Gear Length	0.6240"-0.6242"
Pump Body Counterbore	
Depth	0.6250"-0.6255"
Diameter	1.1660"-1.1667"

SPECIFICATIONS (CONT.)

TRANSMISSION OIL FILTER
Make....AC
Type....Full Flow w/By-Pass Valve
Element Type....Disposable
Number....PF-7
By-Pass Valve Opens at....4.5 to 5.5 psi

TRANSMISSION OIL LOW PRESSURE SWITCH
Make....Hobbs Div. of Stewart-Warner Corp.
Circuit Opens at....1 to 2 psi
Vendor No....MI-1822

REVERSE SOLENOID
Make....Delco-Remy Div.
Number....001535

REVERSE SOLENOID (Cont.)
Volts to Operate....12

Current Draw (Amps.)
- Both Windings....49.5-56.7
- Hold-in Windings....9.53-10.5

1ST AND REVERSE SHIFT MECHANISM
Shift Fork to Sliding Clutch Clearance
- Mainshaft Sliding Clutches....0.005"-0.016"
- Reverse Gear Sliding Clutch....0.005"-0.016"

Reverse Shaft Shift Spring
- Free Length....5 1/16"
- Lbs. Pressure @ 1¾ inch....38-42

TORQUE WRENCH SPECIFICATIONS
(Ft. Lbs.)

Companion Flange Nut....500-550
Mainshaft Nut....300-350
Countershaft Rear Nut....300-350
Countershaft Front Nut....300-350
Drive Gear Outer Bearing Nut....300-350
Bevel Pinion Bearing Nut....500
Bevel Pinion Bearing Cap Bolts....27-32
Bevel Pinion Bearing Retainer Bolts....36-39
Drive Gear Inner Bearing Retainer Bolts....36-39
Shift Lever Studs (In Cover)....240
Oil Filter Element....10-15
Stud Nuts
- Mainshaft Shaft Rear Bearing Cap....35-43
- Countershaft Rear Bearing Cap....53-66
- Bevel Drive Gear Bear Cap....27-32
- Oil Reservoir....27-32
- Clutch Housing....127
- Transmission Cover....27-32

Refer to LUBRICATION (SEC. 13) in this manual for recommended lubricants and intervals of application.

Propeller Shaft

Propeller shaft, used to transmit power from transmission to differential, is tubular type, equipped with heavy duty needle bearing type universal joints (fig. 1).

On SDH and TDH models, flange yoke at slip joint end is bolted to transmission mainshaft companion flange. On SDM and TDM models, slip yoke is connected directly to a fixed yoke which is splined to transmission mainshaft and secured by a nut. Shaft is splined to slip yoke. A steel dust cap which screws onto slip yoke (fig. 6) prevents entry of dust. Flange yoke at fixed joint end is bolted to companion flange at differential.

Slip joint at transmission end of shaft compensates for variation in distance between transmission and differential. These variations are brought about by the rise and fall of the rear axle as the vehicle passes over uneven ground. Slip joint facilitates removal of power plant.

LUBRICATION

Journals of universal joints are drilled and provided with lubrication fittings, through which lubricant travels to all four oil reservoirs (fig. 1) and then, through a hole in side of each reservoir, direct to needle bearings. Needle bearings are protected against lubricant leakage and the entry of dust by gaskets. Splines of slip joint are lubricated through lubrication fitting installed in slip yoke.

Universal joints and slip yoke splines should be lubricated periodically as specified in LUBRICATION (SEC. 13).

YOKE FLANGES

Flanges should be checked at regular intervals to see that lock wire is not broken and that nuts and bolts are tight.

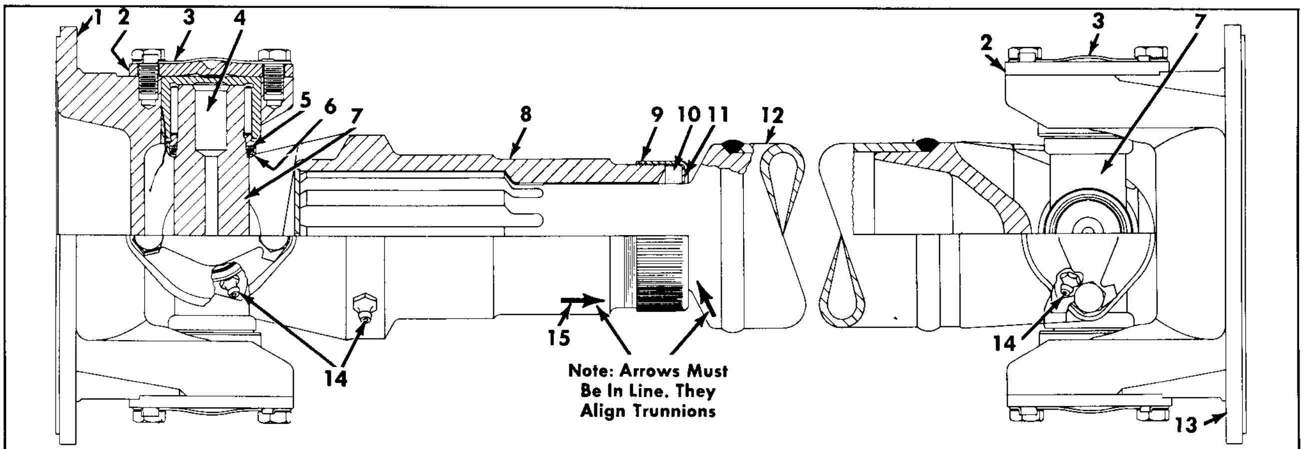
PROPELLER SHAFT AND UNIVERSAL JOINT REMOVAL

Slip yoke and shaft are marked with arrows (fig. 1) to insure correct alignment at assembly. Make sure arrows are clearly discernible before disconnecting slip joint. If arrows are not visible, mark yoke and shaft distinctly.

When it is necessary to remove the propeller shaft from the vehicle when the axle and transmission are in place, use the following steps:

1. Remove nuts and lock washers attaching hand brake drum to differential flange; then slide drum back on propeller shaft.

2. Remove lock wire, nuts, lock washers, and bolts attaching propeller shaft yoke flange to companion flange at differential (fig. 2).



1 Universal Joint Flange (At Transmission)	6 Gasket Retainer	12 Propeller Shaft
2 Bearing Assembly	7 Journal	13 Universal Joint Flange (At Differential)
3 Lock Strap	8 Slip Joint Yoke	14 Lubrication Fitting
4 Lubricant Reservoir	9 Dust Cap	15 Aligning Arrows
5 Gasket	10 Washer (Cork)	
	11 Washer (Steel)	

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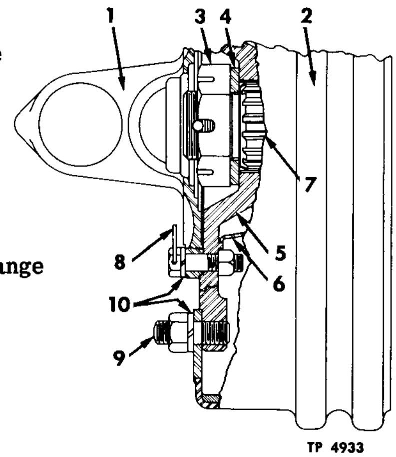
Figure 1—Cross Section of Propeller Shaft Assembly (Typical)



1 Universal Drive Flange
2 Hand Brake Drum
3 Drive Pinion Nut
4 Washer
5 Drive Pinion Companion Flange
6 Oil Slinger
7 Drive Pinion Shaft
8 Lock Wire
9 Flange Stud
10 Lock Washer

Figure 2—Propeller Shaft Installation at Rear Axle

3. On SDH and TDH models remove lock wires, nuts, lock washers, and bolts attaching propeller shaft yoke flange to transmission companion flange (fig. 3).

4. On SDM and TDM refer to "Universal Joint Disassembly" for journal disassembly at transmission end (fig. 4). Refer to TRANSMISSION (SEC. 17) for yoke removal.

5. Unscrew dust cap from slip yoke. On SDH and TDH Models, remove slip yoke and universal joint; on SDM and TDM models, remove slip yoke.

6. Remove propeller shaft and fixed universal joint assembly from under vehicle, removing brake drum from shaft as shaft is removed.

UNIVERSAL JOINT DISASSEMBLY

(Refer to Figure 5)

The following procedures apply to both the slip and fixed universal joint assemblies.

1. Use a chisel or screwdriver and bend ends of lock straps away from cap screws, then remove cap screws and lock straps.

2. Remove needle bearings by tapping with a plastic or rawhide hammer. CAUTION: Never use a steel hammer when removing bearings and do not let bearings drop on floor; this may cause serious damage.

3. Slide journal into one side of yoke as far as possible. Tilt journal to clear yoke and remove.

4. Slide gaskets from journal. Remove lubrication fitting from journal. Unless gasket retainers are to be replaced, do not remove retainers from journals.

CLEANING AND INSPECTION

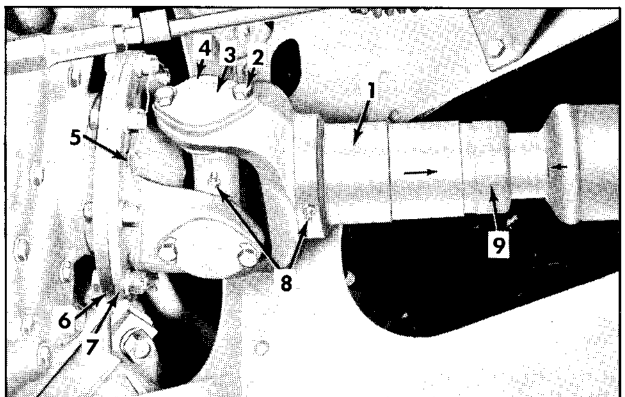
PROPELLER SHAFT

Use a wire brush and clean all dirt and old lubricant from splines on shaft. Inspect for broken or bent splines. Check shaft for warpage or breaks. If warped or broken, it should be replaced. Welding of broken shafts is not recommended.

SLIP AND FIXED JOINT YOKES

Inspect each yoke for cracks, wear, damage, or bent condition.

Small burrs or rough spots can usually be removed with a hone. See "Specifications" at end of this section for clearance between shaft and yoke splines. Replace if defective or badlv worn.



1 Slip Yoke Assy.	6 Transmission Companion Flange
2 Cap Screw	7 Flange Yoke
3 Lock Strap	8 Lubrication Fittings
4 Needle Bearing Assy.	9 Dust Cap
5 Lock Wire	

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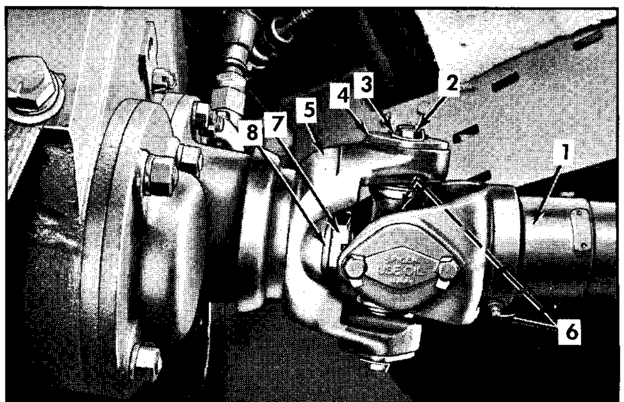
Figure 3—Propeller Shaft Installation at Transmission (SDH and TDH Models)



1 Slip Yoke Assy.	6 Lubrication Fitting
2 Cap Screw	7 Transmission Yoke Nut
3 Lock Strap	8 Transmission Yoke Nut Washer
4 Needle Bearing Assy.	
5 Transmission Yoke	

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Figure 4—Propeller Shaft Installation at Transmission (SDM and TDM Models)

UNIVERSAL JOINTS

Wash all parts with suitable cleaning fluid. Clean all lubricant passages in journals (fig. 5) and lubrication fitting. Soak needle bearing assemblies in cleaner to soften particles of hard grease. Clean bearing assemblies thoroughly, then blow out dirt with compressed air.

IMPORTANT: Be sure that bearing assemblies are clean. Small particles of dirt or grit can cause excessive bearing wear.

Do not attempt to disassemble needle bearings. Inspect journal bearing surfaces for roughness or needle bearing grooves. If grooves and roughness will not smooth out with moderate honing, journal and bearing assemblies should be replaced. Check each bearing assembly for wear and missing rollers (see "Specifications" at end of this section). If rollers drop out of bearing, bearing assemblies should be replaced. After needle bearing assemblies are thoroughly clean, pack with clean grease and turn on journal to check wear.

If excessive clearance is noted, further check of parts is necessary to determine which parts to replace. Inspect gasket and gasket retainer and replace if not in good usable condition.

UNIVERSAL JOINT ASSEMBLY

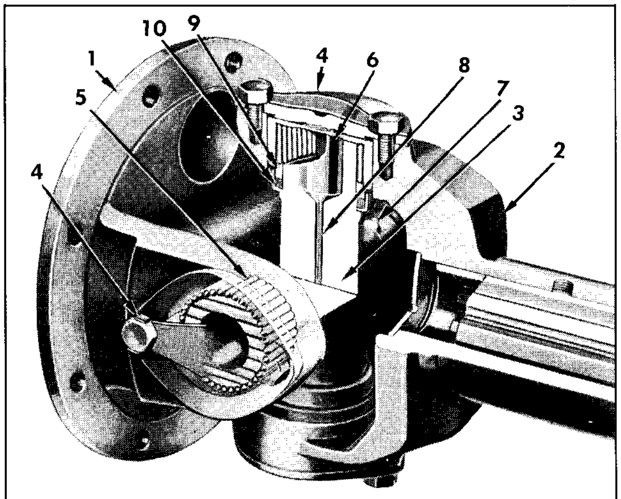
(Refer to Figure 5)

The following procedures apply to both the slip and fixed universal joint assemblies.

1. Install lubrication fitting in journal. If gaskets and gasket retainers were removed, install gasket retainers and gaskets on journals.
2. Insert one end of journal into yoke as far as possible from inside and tilt until opposite end of journal clears yoke and drops into position.
3. Insert bearing assemblies from outside of yoke and tap into place with a rawhide or plastic hammer. Do not use steel hammer for this purpose.
4. Joints should move freely in the bearings and not bind. If joints are too tight, change bearings around until joints are free and operate smoothly in the assembled position.
5. Install new lock straps and cap screws. Tighten cap screws, then bend ends of lock straps against heads of cap screws.

PROPELLER SHAFT INSTALLATION

1. On SDH and TDH Models, install slip joint assembly on transmission companion flange and attach with bolts, lock washers, and nuts. Tighten nuts firmly, leaving notches in nuts aligned with lock wire holes in bolts. Thread lock wire through bolts and twist ends of wire together (fig. 3).
2. On SDM and TDM Models, refer to TRANSMISSION (SEC. 17) for yoke installation. Refer to "Universal Joint Assembly" and assemble slip joint to yoke (fig. 4).
3. Install dust cap, steel washer, and cork washer on fixed joint end of shaft (fig. 6).
4. Apply a thin coating of lubricant recommended in LUBRICATION (SEC. 13) on propeller shaft splines. Place hand brake drum over fixed end of shaft, then place shaft assembly in position under vehicle. Align arrows as shown in figure 1. Insert splined end of shaft into slip joint, with arrows on slip yoke and shaft aligned as shown in figure 1.
5. Position fixed joint flange at differential companion flange and attach with bolts, lock washers, and nuts. Bolt nuts should be positioned so that



1 Yoke Flange
2 Slip Yoke
3 Journal
4 Lock Strap
5 Needle Bearing Assembly
6 Oil Reservoir
7 Lubrication Fitting
8 Lubricant Passage
9 Gasket
10 Gasket Retainer TPM-1334

Figure 5—Cross Section of Universal Joint

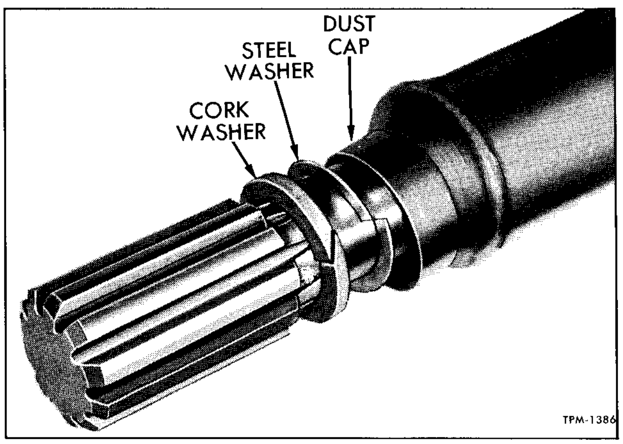


Figure 6—Propeller Shaft with Slip Joint Removed

they will lock against shoulder on differential companion flange. Tighten nuts firmly, then thread lock wire through bolt heads and twist ends of wire together. Assemble hand brake drum to differential companion flange (fig. 2).

6. Place cork and steel washer against end of slip yoke, then thread dust cap onto slip yoke. Tighten dust cap by hand. CAUTION: Do not use wrench.

7. Lubricate universal joints and slip joint with lubricant specified in LUBRICATION (SEC. 13).

SPECIFICATIONS

Universal Joint (Slip Joint End)	1701 Series
Universal Joint (Fixed Joint End)	1708 Series
Shaft Diameter	3½"
Journal Diameter	1.3201"-1.3206"
Bearing Rollers	
Number of Rollers	36
Diameter	⅛"
Length	0.920"-0.925"
Slip Joint	
Yoke Spline Thickness	0.3885"-0.3900"
Shaft Spline Thickness	0.3855"-0.3870"
Clearance—Shaft Splines to Slip Yoke Splines	0.0015"-0.0045"

Hubs, Wheels, and Tires

> This group includes two sections covering maintenance information on HUBS AND BEARINGS and WHEELS AND TIRES.

Hubs and Bearings

Wheels and hubs are carried on two opposed tapered roller bearings as shown in figures 1 and 2. Bearings are adjustable for wear. Satisfactory operation and long life of bearings depend upon proper adjustment and correct lubrication. If bearing adjustment is too tight, bearings will overheat and wear rapidly. Loose adjustment of bearings will result in pounding and will contribute to steering difficulties, uneven tire wear, and inefficient brakes. Before checking or adjusting wheel bearings, always be sure brakes are fully released and not dragging. Wheel studs are installed in hub flange as shown in figures 1 and 2. Brake drums are mounted over wheel studs on outer side of hub flange and attached to hub with countersunk screws.

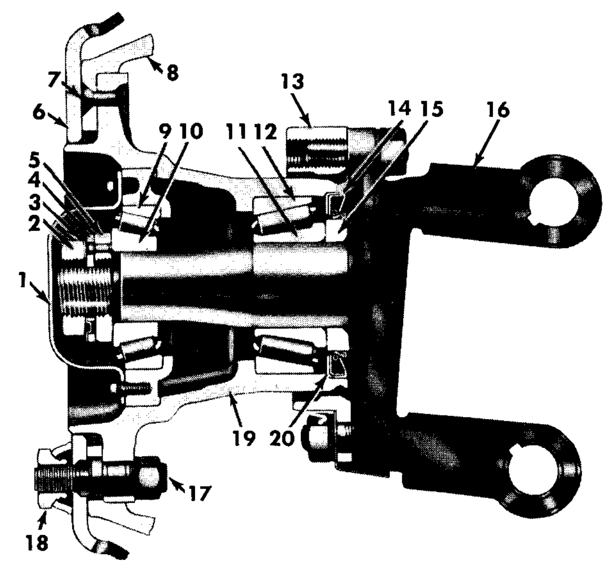
BEARING ADJUSTMENT

Wheel bearing adjustment should be checked carefully at each inspection period. Jack up wheels one at a time and check bearing play by using a pry bar under tires. Observe movement of brake drum in relation to brake spider or brake shoes. If bearings are adjusted correctly, movement of brake drum will be just noticeable and wheel will turn freely with no drag. If test indicates that adjustment of bearings is necessary, make adjustments as follows:

FRONT WHEEL BEARINGS

Key numbers in text refer to figure 1.

1. Remove cap screws and lock washers which attach hub cap (1) to hub (19); then remove hub cap and gasket.
2. Raise lip of nut lock (3) and remove lock nut (2), nut lock (3), and lock ring (4) from steering knuckle spindle (16).
3. Tighten wheel bearing adjusting nut (5) until wheel binds, at the same time turning wheel to make sure all surfaces are in proper contact.
4. Back off bearing adjusting nut (5) 1/6 turn, or more if necessary, making sure wheel turns freely.
5. Position lock ring (4) on steering knuckle spindle, with dowel pin in adjusting nut (5) inserted into hole of lock ring (4). Either side of ring may be turned toward adjusting nut. When installing lock ring, place first one side then the other toward adjusting nut, to determine which position will permit dowel pin in nut to line up with hole in ring, with least change in position of adjusting nut.
6. Install nut lock (3) and lock nut (2) on steering knuckle spindle. Draw lock nut up tight.
7. Recheck wheel bearing adjustment as described previously; then bend lip of nut lock (3) down against flat of lock nut (2).
8. Position hub cap (1) and new gasket against hub; then attach with cap screws and lock washers.



1 Hub Cap
2 Lock Nut
3 Nut Lock
4 Adjusting Nut Lock Ring
5 Bearing Adjusting Nut
6 Wheel
7 Brake Drum Retaining Screw
8 Brake Drum
9 Outer Bearing Cup
10 Outer Bearing Cone and Roller Assy.
11 Inner Bearing Cone and Roller Assy.
12 Inner Bearing Cup
13 Brake Spider
14 Oil Seal
15 Bearing Spacer
16 Steering Knuckle
17 Wheel Stud
18 Wheel Nut
19 Hub
20 Oil Seal Washer

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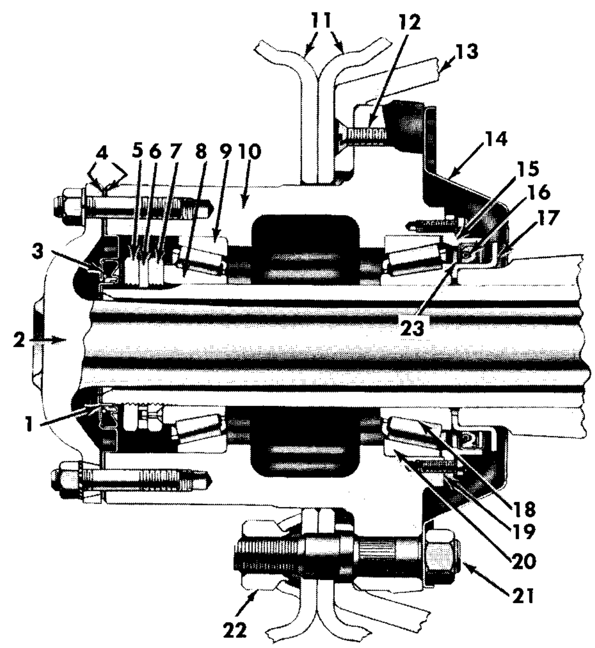
Figure 1—Front Hub and Bearings (Typical)



1	Oil Seal Wiper and Cork Assembly	12	Brake Drum Retaining Screw
2	Axle Shaft	13	Brake Drum
3	Outer Oil Seal Assembly	14	Oil Slinger
4	Gaskets	15	Oil Seal Retainer
5	Lock Nut	16	Inner Oil Seal
6	Lock Ring	17	Oil Seal Wiper Sleeve
7	Bearing Adjusting Nut	18	Inner Bearing Cone and Roller Assembly
8	Outer Bearing Cone and Roller Assembly	19	Gasket
9	Outer Bearing Cup	20	Inner Bearing Cup
10	Hub	21	Wheel Stud
11	Wheels	22	Wheel Nut
		23	Oil Seal Washer

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Figure 2—Rear Hub and Bearings (Typical)

REAR WHEEL BEARINGS

Key numbers in text refer to figure 2.

1. Remove axle shaft as directed in REAR AXLE (SEC. 2) of this manual.

2. Remove gaskets (4) and wheel bearing outer oil seal (3) from axle shaft flange studs.

3. Remove wheel bearing outer oil seal wiper and cork assembly (1) from end of axle housing tube.

4. Unscrew lock nut (5) and remove adjusting nut lock ring (6) from axle housing tube.

5. Tighten wheel bearing adjusting nut (7) until wheel binds, at the same time turning wheel to make sure all surfaces are in proper contact.

6. Back off adjusting nut (7) about 1/6 turn, or more if necessary, to make sure wheel turns freely.

7. Position lock ring (6), with dowel pin in adjusting nut (7) inserted in hole of lock ring (6). Either side of ring may be turned toward adjusting nut. When installing lock ring, place first one side then the other side of ring toward adjusting nut, to determine which position will permit dowel pin in nut to line up with hole in lock ring with least change in position of adjusting nut.

8. Install lock nut (5) and tighten firmly; then recheck bearing adjustment as described previously.

9. Press oil seal wiper and cork assembly (1) on end of axle housing tube.

10. Place new oil seal inner gasket (4) on hub over axle shaft flange studs.

11. Coat lip of outer oil seal (3) and oil seal wiper and cork assembly (1) with grease; then install oil seal with holes in retainer over axle shaft flange studs. If oil seal is damaged or worn, even slightly, use a new oil seal.

12. Position new outer gasket (4) on hub over axle shaft flange studs.

13. Install axle shaft as directed in REAR AXLE (SEC 2) of this manual.

OIL SEALS

Front and rear hubs have oil seals at inner end to prevent leakage of wheel bearing lubricant from hubs into brake drums. Inner oil seals also prevent water and dirt from entering hubs and contaminating wheel bearing lubricant. Oil seals at outer end of rear hubs prevent rear axle differential lubricant from entering hubs and mixing with wheel bearing lubricant.

Inner seals used in both front and rear hubs are rotating, spring-loaded type. Front seals are pressed into inner end of hub and seal lip wipes on bearing spacer (fig. 1). Rear hub inner seals are pressed into seal retainers. Retainers are attached to inner end of hub with screws. Seal lip wipes on a wiper sleeve. Wiper sleeve is pressed on rear axle housing tube (fig. 2).

Outer seals used in rear hubs are spring loaded lip-type seals with integral retainers. Retainers fit over axle shaft drive plate studs. Lip of oil seal wipes on oil seal wiper. Wiper is pressed on outer end of axle housing tube. Wiper to tube cork gasket is cemented to inner side of wiper.

At regular inspection periods, examine all seals carefully. If there is the slightest indication of wear, deterioration, or damage at sealing surface, a complete new oil seal assembly must be

installed. Examine surface of oil seal wiper, wiper sleeve, and bearing spacer, against which oil seals bear. Any nicks, scratches, or rough spots, on these surfaces will impair efficiency of seals.

Always spread a thin coating of grease on face of oil seal, oil seal wiper, wiper sleeve, and bearing spacer before installing parts in hub.

FRONT HUB AND BEARING REMOVAL

Key numbers in text refer to figure 1.

1. Raise front end of coach until tires just clear floor.
2. Remove wheel stud nuts and remove wheel and tire.
3. Remove brake drum to front hub retaining screws (7); then remove brake drum (8) from hub (19).
4. Remove cap screws and lock washers; then remove hub cap (1) and gasket.
5. Raise lip of nut lock (3); then remove lock nut (2), nut lock (3), lock ring (4), and bearing adjusting nut (5) from steering knuckle spindle.
6. Pull front hub assembly (19) straight off spindle, being careful not to permit outer bearing (10) to fall out of hub (19).
7. Remove outer bearing cone and roller assembly (10) from hub (19).
8. Pull inner bearing oil seal (14) and washer (20) out of hub (19); then lift inner bearing cone and roller assembly (11) from hub (19).
9. Perform cleaning and inspection operations outlined under "Cleaning and Inspection" later in this section. If inspection indicates need for replacing inner (12) and outer (9) bearing cups, they may be driven out of hub by using a long brass drift and hammer through opposite end of hub.
10. If necessary to remove bearing spacer (15), drive a chisel between inner edge of spacer and steering knuckle spindle (16) to force spacer out far enough to permit use of a puller. Be extremely careful not to mar or damage steering knuckle spindle with chisel.

REAR HUB AND BEARING REMOVAL

Key numbers in text refer to figure 2.

1. Raise rear end of vehicle until tires just clear floor.
2. Remove wheel stud nuts (22 and 23); then remove wheels and tires.
3. Remove brake drum to hub retaining screws; then remove brake drum (13) from hub (10).
4. Remove axle shaft (2) as directed in REAR AXLE (SEC. 2) of this manual.
5. Remove wheel bearing outer oil seal and retainer assembly (3) and gaskets (4) from axle shaft flange studs.
6. Remove wheel bearing outer oil seal wiper and cork assembly (1) from end of axle housing tube.
7. Remove lock nut (5), lock ring (6), and bearing adjusting nut (7) from axle housing tube.
8. Lift rear hub (10) off axle housing tube, holding hand over outer end of hub to prevent outer bearing (8) from falling out. Remove outer bearing cone and roller assembly (8) from hub (10).
9. Remove screws attaching inner oil seal retainer (15) to hub; then remove inner oil seal (16) and retainer assembly (15) and gasket (19) from hub. If desired inner oil seal (16) and washer (24) can be pushed out of oil seal retainer (15).
10. Lift inner bearing cone and roller assembly (18) out of hub (10).
11. If necessary to remove inner oil seal wiper sleeve (17), as indicated under "Cleaning and Inspection" later in this section, use a chisel or suitable tool and drive sleeve off axle housing. Be careful not to damage axle housing tube.
12. If necessary to remove inner (20) and outer (9) bearing cups as indicated under "Cleaning and Inspection" later in this section, they may be driven out of hub by using a hammer and long brass drift through opposite end of hub.

CLEANING AND INSPECTION

CLEANING

1. Immerse bearing cone and roller assemblies in clean cleaning solvent. Clean bearings with stiff brush to remove old lubricant. Blow bearings dry with compressed air, directing air stream at right angles to bearing. DO NOT SPIN BEARINGS WITH AIR PRESSURE WHILE BLOWING THEM DRY.
2. Thoroughly clean all old lubricant out of inside of hubs; then wipe hubs dry. Make sure all particles of old gasket are removed from inner end of rear hubs.
3. Clean all lubricant off rear axle housing tube and front axle steering knuckle spindle. Do not permit cleaning solvent or grease to get on brake linings.
4. Using a clean cloth dampened with cleaning solvent, wipe old lubricant off oil seals.
5. Wash all small parts such as bearing nuts, lock rings, and oil seal wipers in cleaning solvent. Wipe or blow parts dry.

INSPECTION

1. Inspect bearing rollers for excessive wear, chipped edges, or other damage. Slowly rotate roller bearings around cone to detect any flat or rough spots on cone or rollers. Do not mistake dirt or grit for roughness. Replace bearing assemblies if any damage is found.
2. Examine bearing cups in hubs. If cups are

pitted or cracked, they must be replaced with new parts.

3. Carefully examine oil seals for signs of wear, deterioration, distortion, or damage at sealing surfaces. Replace oil seal assembly if any of the above conditions are evident.

4. Inspect oil seal wiper, wiper sleeve, and bearing spacer for nicks or rough spots which would cause rapid wear of oil seals. Replace with new parts as required.

5. After inspection is completed and parts replaced as deemed necessary, lubricate bearings and inside of hub as directed in LUBRICATION (SEC. 13).

FRONT HUB AND BEARING INSTALLATION

Key numbers in text refer to figure 1.

1. If inner bearing spacer (15) was removed, drive into place on steering knuckle spindle. Make sure spacer is fully seated against knuckle flange.

2. If inner (12) and outer (9) bearing cups were removed from hub, drive or press new cups into hub with wide side of cups toward inside of hub. Make sure cups are fully seated against shoulder in hub and not cocked.

3. Be sure inner (10) and outer (11) wheel bearings and inside of hub are well lubricated as directed in LUBRICATION (SEC. 13).

4. Position inner bearing cone and roller assembly (11) inside hub (19).

5. Place oil seal washer (20) in hub (19); then press oil seal (14) into hub against washer. Lip of oil seal must point toward inside of hub.

6. Coat face of inner oil seal (14) and bearing spacer (15) with grease.

7. Install hub assembly (19) on front axle steering knuckle spindle. Be careful not to damage wheel bearing oil seal assembly (14).

8. Place outer bearing cone and roller assembly (10) on steering knuckle spindle (16); then push bearing into hub with fingers.

9. Install wheel bearing adjusting nut (5) on steering knuckle spindle. Tighten adjusting nut against outer bearing finger-tight.

10. Position brake drum (8) on flange of hub (19) and attach with retaining screws.

11. Place wheel and tire on hub; then attach with stud nuts. Tighten stud nuts as directed in "WHEELS AND TIRES."

12. Adjust front wheel bearings and complete installation as previously directed under "Bearing Adjustment" earlier in this section.

REAR HUB AND BEARING INSTALLATION

Key numbers in text refer to figure 2.

1. If inner oil seal wiper sleeve (17) was removed from axle housing, reinstall wiper sleeve on housing.

2. If inner and outer bearing cups (9 and 20) were removed from hub (10), drive or press new cups into hub with wide side of cups toward inside of hub. Make sure cups are fully seated against shoulder in hub and not cocked.

3. Lubricate wheel bearings and inside of hub as directed in LUBRICATION (SEC. 13).

4. If oil seal (16) was removed from retainer (15), install washer (24), then press new seal assembly into retainer. Use extreme care when pressing oil seal into place not to distort seal flange.

5. Place inner bearing cone and roller assembly (18) inside hub (10); then position inner oil seal (16) and retainer (15) on inner end of hub, using new oil seal gasket (19) between retainer and hub.

6. Attach retainer (15) to hub (10) with screws and lock washers. Tighten screws evenly and firmly.

7. Coat face of oil seal (16) and oil seal wiper sleeve (17) with grease.

8. Position hub assembly (10) on axle housing tube. Be careful not to damage inner oil seal (16).

9. Place outer bearing cone and roller assembly (8) on axle housing tube. Push bearing into hub with fingers.

10. Install bearing adjusting nut (7) on axle housing tube. Tighten adjusting nut against outer bearing finger-tight.

11. Position brake drum (13) on flange of hub (10) and attach with retaining screws.

12. Install wheels and tires on hubs and attach with wheel stud nuts. Tighten stud nuts as directed in "WHEELS AND TIRES."

13. Adjust rear wheel bearing; then complete installation as previously directed under "Bearing Adjustment" in this section.

Wheels and Tires

WHEEL MAINTENANCE

These coaches may be equipped with either Motor or Budd type wheels. When Budd type wheels are used, wheel studs and nuts on left side of vehicle have left-hand threads, and studs and nuts on right side have right-hand threads. When Motor wheels are used, all studs and nuts have right-hand threads.

1. Before new vehicle goes into service and after each wheel removal, all wheel stud nuts should be thoroughly tightened. Refer to instructions later for wheel nut torque and wheel nut tightening procedure. See that studs and nuts are free from grease or oil. Do not use oil on studs or nuts.
2. To tighten stud nuts on dual rear wheels with Budd type wheels, loosen outer nuts, then tighten inner nuts. Tighten opposite nuts alternately so that wheel will be square against hub flange. After tightening inner nuts, tighten outer nuts to specified torque. On Motor wheels, make sure that inner dual is flush against hub flange, then tighten nuts to specified torque.
3. Re-tighten stud nuts every 100 miles for first 500 miles to offset setting-in of clamping surfaces.
4. Inspect wheel stud nuts at least every 1000 miles thereafter. If vehicle is subjected to severe service, inspection should be made daily regardless of mileage.
5. When changing wheels or tires and before assembling wheels to hubs, remove dirt, grease, and excess paint from the mating surfaces. Dual rear wheels should be positioned with valve stems 180 degrees apart.

WHEEL NUT TORQUE

Excessive tightening of wheel stud nuts has proven to be the cause of erratic brake action in some cases. Where excessive torque is applied, brake drum distortion will occur.

Improper procedure in tightening of wheel stud nuts, including excessive torque, has also been found to cause wheel distortion and wheel runout. Such condition will have decided effect on tire life. Wheel nuts should be carefully torqued to within limits listed in "Specifications" at end of this section. These limits should not be exceeded.

These specifications have proven to be entirely satisfactory to insure wheel tightness and torque applied exceeding these limits is not recommended. To insure correct torque, a large size torque wrench should be used. A number of torque wrenches suitable to this application are available, one of which is made by "Snap-On" in a 0 to 600 foot-pounds capacity with a 3/4" drive. "Snap-On" tool number is TA 602A, and is also available with a light indicator under tool number TQ602AL. If a pneumatic impact wrench is used for tightening wheel stud nuts, it should be used only for initial "run-in" of nuts in order to allow wheel to correctly position itself on the hub. Final tightening should be done with a torque wrench to insure that all nuts are torqued evenly and not beyond the limits shown in "Specifications."

WHEEL STUD NUT TIGHTENING PROCEDURE

It is important that wheel stud nuts be tightened alternately on opposite sides of wheel. A suggested sequence for tightening is shown in figure 3, and a recommended procedure is as follows:

1. Run the stud nuts in lightly, following the sequence shown, so that wheel will position itself concentrically with hub. THIS IS IMPORTANT, OTHERWISE WHEEL MAY BE ECCENTRIC WITH HUB AND WILL NOT RUN TRUE. In this initial step, run the nuts up only as necessary to correctly position wheel.
2. Tighten nuts progressively, in the sequence shown in figure 3, with torque wrench until torque limit is reached. Do not tighten each nut completely at one time but progress from one nut to another so that wheel is tightened uniformly.

WHEEL INSPECTION

Do not use wheels with bent rims. Continued use of wheels with bent rims will result in exces-

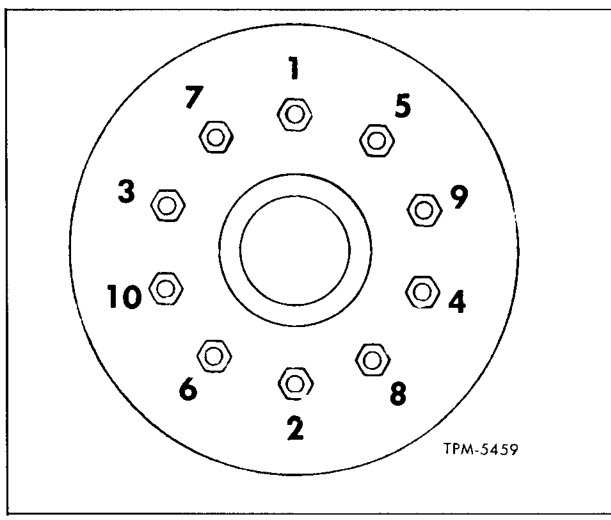

Figure 3—Wheel Nut Tightening Sequence

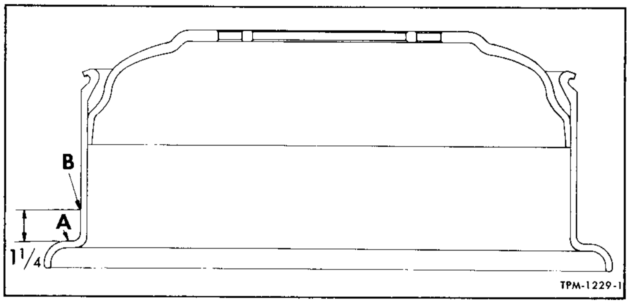

Figure 4—Typical Wheel Checking Diagram

sive tire wear and, if wheel is mounted on front of vehicle, difficulty in steering vehicle will be experienced. Wheels that are thought to be distorted should be checked as follows (see fig. 4):

1. Remove wheel from vehicle and dismount tire.
2. Clean all rust, scale, dirt, and grease from rim.
3. Mount wheel securely in lathe or other suitable fixture. NOTE: Face of hub must run true, as any run-out at that point will be increased from 1-1/2 to 3 times at checking points on rim.
4. Revolve wheel slowly and check at point "A" for lateral runout (wobble). This should not exceed 3/32-inch. Check at point "B" for radial run-out (out-of-round). This should not exceed 3/32-inch total indicator reading. Wheels that are distorted in excess of these limits should be replaced.

TIRE MAINTENANCE

Some coaches are equipped with tubeless tires, while others have tube type tires.

One of the most important factors of economical and safe motor vehicle operation is systematic and correct tire maintenance. Tires must not only support weight of loaded vehicle, but they are also integral parts of the transmission and braking systems. Therefore, tires should receive careful, systematic, and regular maintenance as do other operating units. Three major causes of tire trouble are (1) improper-inflation, (2) overloading, and (3) misalignment. Tires should be checked periodically for these conditions.

INFLATION OF TIRES

Improper-inflation is the greatest cause for loss of tire life expectancy. Tires should be checked frequently for this condition. Tire fabric, rubber, bead, contour, and size used on these vehicles are designed to obtain maximum length of service under all operating conditions to which vehicles may be subjected. TIRES ARE DESIGNED TO OPERATE EFFICIENTLY ONLY ON A PRESCRIBED AMOUNT OF AIR. Unless correct air pressure is consistently maintained, tires will not function as they should; consequently, safe, economical operation of vehicle will be materially affected.

Operating air pressure recommended by the tire manufacturer is as essential to safe and economical operation of tire, as proper amount of oil would be to an engine or other chassis units.

An under-inflated tire runs sluggishly, heats up quickly because of greater flexing, and is subjected to more frequent bruising.

Over-inflation does not compensate for overloading. It does not add strength to tire, in fact, it actually weakens the tire by reducing its ability to absorb road shock, and may cause a blow-out.

In addition to the deteriorating effect improperly-inflated tires may have on tire life, improperly-inflated tires will effect steering, riding comfort, and safe driving.

Tires are designed to operate at a certain recommended inflation, which provides normal flexing with proper deflection and road contact. If flexing is changed from normal, either by over-inflation, under-inflation, or overloading, proper service from tire cannot be obtained. FOLLOW TIRE PRESSURE RECOMMENDATIONS OF THE TIRE MANUFACTURER.

BALANCED INFLATION

The operating efficiency of vehicle will be seriously upset if air pressures in tires are out of balance. Balanced inflation may be expressed as; all tires on the same axle should always carry same air pressure. A difference in air pressure of rear tires and front tires may be permissible within certain limitations; however, there should not be a difference in pressures between right and left tires on the same axle. A five pound under-inflation in one front tire not only can destroy ease of steering, but creates steering hazards which generally point to a potential accident. An under-inflated rear tire can destroy the value of the most efficient brakes. Balance tire pressures for ease of steering, comfort in riding, safety in driving, as well as for minimum fuel consumption and maximum tire mileage.

PRESSURE LOSS

At periodic intervals, each tire should be gauged for pressure loss with an accurate gauge before tires are brought to correct operating pressure. Purpose of this check is to determine exact pressure losses in each tire. In other words, if at the time this check is made, a definite pressure loss is noted in any one of the tires, an inspection should be made of tire showing loss and cause of loss corrected. This method should definitely establish a "danger signal" on the condition of tires. Pressure loss check should be made consistently with the same gauge, so that any element of inaccuracy in gauge will be the same for all tires.

ROTATION OF TIRES

Tires should be interchanged at regular intervals to obtain maximum life. Change wheels without dismounting tires so direction of rotation will be reversed. The following system of interchanging is suggested: Right front to left rear inside or right rear outside. Left front to right rear inside or left rear outside.

If inside dual tires show more wear than outside dual tires, place front tires on inside when changing. In this case, outside dual tires can be interchanged between right- and left-hand side of vehicle.

If outside dual tires show more wear than inside dual tires, place front tires on outside dual tires when changing. At the same time, interchange right- and left-hand inside dual tires.

New tires should be installed on front wheels where they run coolest.

TIRE VALVES

The valve core is a spring-loaded check valve installed in valve stem, permitting inflation or deflation of the tire. This check valve, or core, is not intended to hold the air during operation. The valve cap is provided to seal air in the tube or tire. When valve cap is tightened down on stem, the sealing washer inside cap is pressed tightly against top of stem, preventing air leakage. Valve cap also prevents dirt and moisture from entering valve stem to injure valve core mechanism. It is important, therefore, that valve caps be used.

SELECTION OF TIRES

All tires on the same axle should, whenever possible, be of the same make, since differences in design and tread in some instances result in unequal tire rolling radii. It is not possible to match all tires exactly. Therefore, some tolerance must be permitted. When installing tires on a vehicle, all tires on same axle should have the same outside diameter within tolerance limits. The most desirable matching is obtained by not exceeding 3/4-inch difference in circumference or 1/4-inch difference in diameter. If tires do not have the same outside diameter (within 1/4-inch) excessive tread scuffing and hard steering will result. Tire diameters may be measured with a conventional tire measuring gauge.

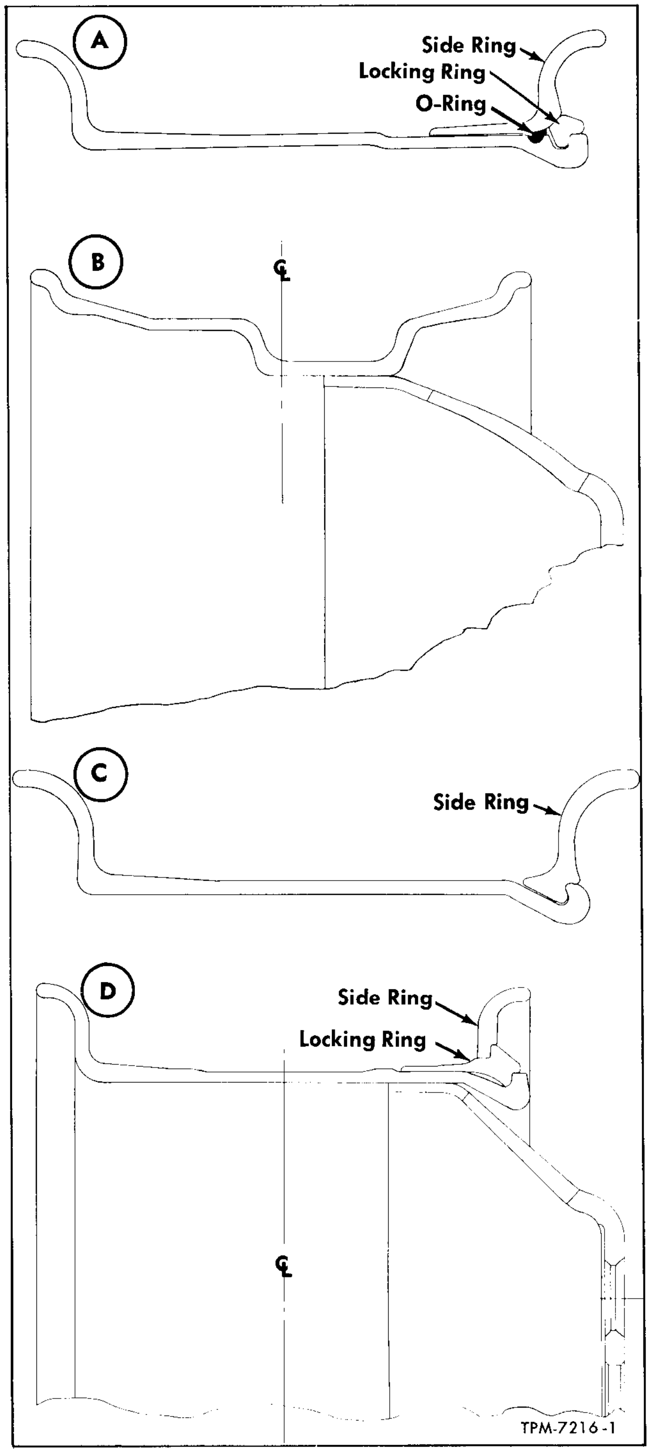

Figure 5—Typical Wheel Rims

TIRE REPLACEMENT

The standard wheel rims shown in view A, figure 5, are flat base rims with a side ring and locking ring. The toe of the side ring forms the seat for the tire bead. Either tubeless or tube type tires can be used on this rim. When tubeless tires are used, a black Neoprene O-ring is used to seal air in. When tube type tires are used, a red vinyl O-ring is used to exclude dirt and water.

Wheel rim shown in view B, figure 5, is an optional one-piece drop-center rim that requires no side ring or locking ring. This wheel is used exclusively with tubeless tires.

Wheel rim shown in view C, figure 5, is an optional flat base rim having a one-piece continuous type side ring. Tube type tires only are used with this type rim.

Another optional flat base rim is shown in view D, figure 5. This rim has a continuous type side ring and a locking ring. The toe of the locking ring forms the tire bead seat. Tube type tires only are used with this type rim.

IMPORTANT: Most "rim accidents" are caused by carelessness and thoughtlessness when inflating tires after mounting. Such accidents are always serious and sometimes fatal. Be on the safe side - ALWAYS FOLLOW PRECAUTIONS DESCRIBED IN THE FOLLOWING:

On all wheels using lock ring, the lock ring must be fully seated in rim gutter before inflating tire. This is important for the safety of person inflating tire.

As an added precaution, use a steel bar 1" in diameter and long enough to extend several inches over lock ring at both ends. Bend bar so it can be inserted through wheel spoke openings with both ends of bar extending over lock ring. Leave bar in place until tire is fully inflated. Examine lock ring to see that it is fully seated; then remove safety bar.

WHEEL NUT TORQUE SPECIFICATIONS

Motor Wheel - Front and Rear Wheels . . .	500-550 Ft.-Lbs. - No Lubricant
Budd Type - Front Wheel Nuts and Rear Wheel Inner and Outer Nuts	500-550 Ft.-Lbs. - No Lubricant

Air Conditioning

This group, covering operation, maintenance, and repair information on GM Air Conditioning is divided into eight major sections as shown in index below:

Information pertaining to a specific control, service, or test, will be found by using quick page reference index shown at beginning of each respective section.

NOTE: Air conditioning controls and units, such as temperature control Grad-U-Stat (thermostat), underfloor blowers, heater core unit, and air filter screens are also used in conjunction with the coach heating system. These controls and units which are common to both systems are covered in "HEATING AND VENTILATION" (SEC. 3) in this manual.

General Description

The GM coach air conditioning is designed to provide passenger comfort by cooling, dehumidifying, and filtering the air which is force-circulated within the coach.

The air conditioning system is entirely independent of the coach heating system; however, the entire heating system is utilized to control or temper the air which is cooled by air conditioning. This tempering or temperature-raising process provides the necessary "reheat" phase of air conditioning system.

The air conditioning system units are accessible in coach through access doors shown in figure 1. System units are located schematically in coach as shown in figure 2.

Briefly, the air conditioning system is comprised of the following system and controls. Refer to figure 2.

THE CONDENSING SYSTEM

The condensing system consists of:

1. A Four-Cylinder Reciprocating-Type Refrigerant Compressor, shaft-driven from accessory drive take-off of coach engine. Compressor is mounted below floor, forward of engine bulkhead at left side of coach.

2. A Fin and Tube-Type Condenser Coil with an eight-blade type cooling fan. Condenser and fan are mounted to roof structure at rear of coach. Fan blade is hydraulically driven from a fluid pump which is mounted to, and belt-driven from refrigerant compressor.

3. A Liquid Refrigerant Receiver which is mounted to understructure at left side near center of coach.

THE COOLING UNITS

The cooling units consists of:

1. An Evaporator Coil of fin and tube-type construction mounted in underfloor heating and cooling compartment. Coil is accessible from underneath coach, after lowering compartment access panel and doors.

2. A Refrigerant Expansion Valve of multi-outlet-type mounted to evaporator coil and refrigerant liquid line. Expansion valve is also accessible from underneath coach.

3. A Refrigerant Heat Exchanger of tank and internal coil-type is mounted into both high pressure liquid line and low pressure gas line. Heat exchanger is accessible after opening side closure door near left center of coach (fig. 1).

4. A Dehydrator-Strainer of disposable-type is mounted in high pressure liquid line in same compartment as the heat exchanger above.

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GENERAL DESCRIPTION

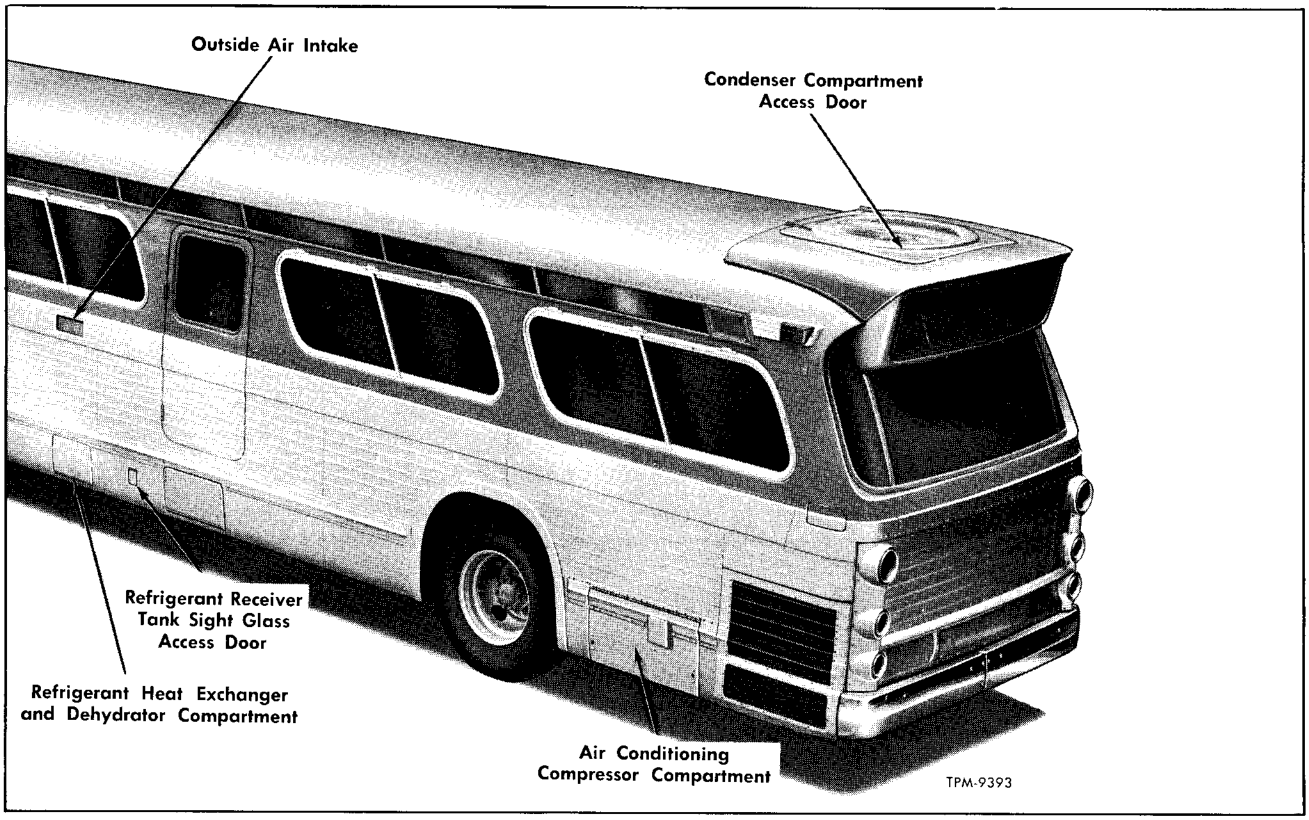


Figure 1—Access Doors to Air Conditioning Units

THE AIR CIRCULATION SYSTEM

The Air Circulating System consists of same air intakes, filter screens, blowers, and air distribution ducts which are employed for coach heating.

SYSTEM CONTROL UNITS

The air conditioning system controls consist of "VENTILATION" switch on panel at left of driver, an electrically-energized air-operated friction clutch mounted to drive end of refrigerant compressor, and automatic controls such as pressure switches, relay and air supply solenoid valve which are described later under "System Operation."

DRIVER'S OPERATING INSTRUCTIONS

Driver's control of air conditioning is accomplished by the positioning of switch marked "VENTILATION" mounted on control panel at left of driver. Switch positions are marked "AIR CONDITION," "BLOWER - LOW - HI" and "OFF."

TO OPERATE COOLING SYSTEM

With engine running at idle speed, rotate switch knob to "AIR CONDITION" position. With switch in this position, the underfloor blower high speed circuit is energized and blowers run continuously at high speed. Except for this action the operation of the air conditioning is completely automatic.

A short delay may occur before air conditioning system starts to operate. Two likely reasons for this condition are:

1. Engine oil pressure too high at normal idle. Engine oil pressure switch contacts will not close to complete circuit to air conditioning controls if oil pressure exceeds 15 psi. Engagement will occur as soon as oil warms up and pressure drops below 15 psi.

2. Pressure in coach air system is low: A minimum of 65 psi air pressure is required to operate compressor clutch controls. Build up required air pressure.

NOTE

The "A/C STOP" tell-tale located at bottom of gauge and tell-tale panel in front of driver will illuminate whenever the refrigerant "HI-LO" pressure switch contacts are open and compressor clutch is disengaged. If light stays on and coach temperature rises, report condition to service personnel.

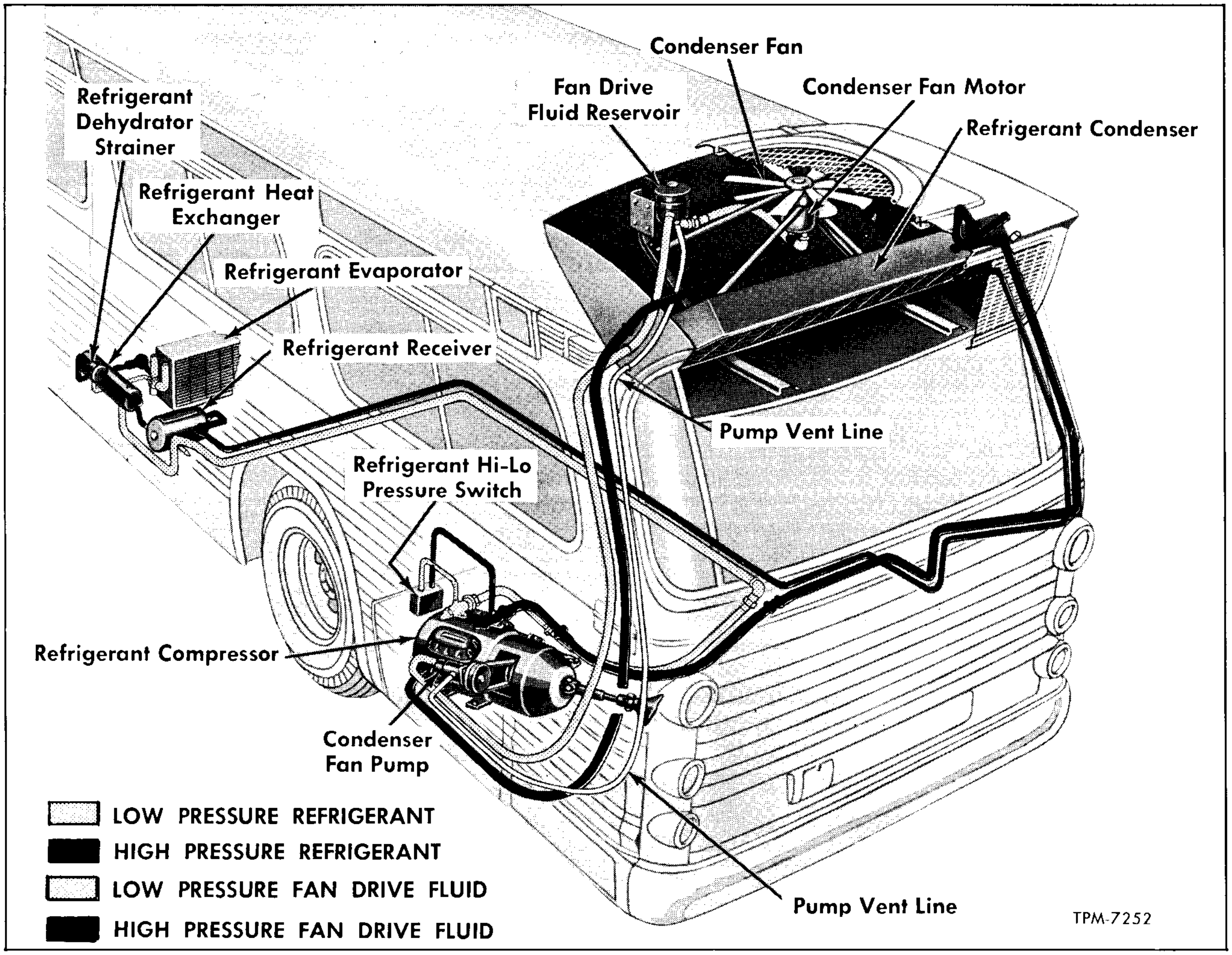


Figure 2—Refrigerant Lines and Condenser Fan Drive Fluid Lines

IMPORTANT: KEEP WINDOWS AND OUTSIDE AIR FRONT INTAKES CLOSED AND DO NOT LEAVE DOORS OPEN ANY LONGER THAN NECESSARY.

TO OPERATE HEATING SYSTEM

"VENTILATION" switch on vehicles having air conditioning need not be positioned to "BLOWER - HI" or "LOW" for heating system to operate, as underfloor blowers will run at low speed whenever the Grad-U-Stat (thermostat) calls for heat. However, on these vehicles the switch can be positioned to "BLOWER - HI" or "LOW" as desired to provide ventilation regardless of the demands of Grad-U-Stat.

IMPORTANT

Excessive use of defroster heater at front end may cause high temperature in front of coach, thereby satisfying the thermostat control and leaving the rear area in the coach cold. For information covering operation of outside air vents over the windshield and for right and left front air intakes, refer to current OPERATING MANUAL.

System Operation

CONTENTS OF THIS SECTION

GENERAL OPERATION

Some controls and units used with the air conditioning system are common to the coach heating system. These controls and units are: "VENTILATION" control switch, marked "AIR CONDITION," "BLOWER - LOW-HI," and "OFF," air filter screens, heater core unit, air intake and distribution ducts, and the Grad-U-Stat.

The heating and cooling systems operate independently of each other, except under certain conditions of cooling system operation when there is an overlapping operation of both systems as explained previously under "GENERAL DESCRIPTION."

When the "VENTILATION" switch on panel at left of driver is placed in "AIR CONDITION" position, the air conditioning system functions as follows:

NOTE: Follow the schematic wiring diagram (fig. 3) for simplified electrical circuits or refer to the Air Conditioning Wiring Diagram in back of this manual for detailed diagram of electrical circuits and connections.

1. With engine running and control switch closed, underfloor blower high speed circuit is energized and blowers run continuously at high speed.

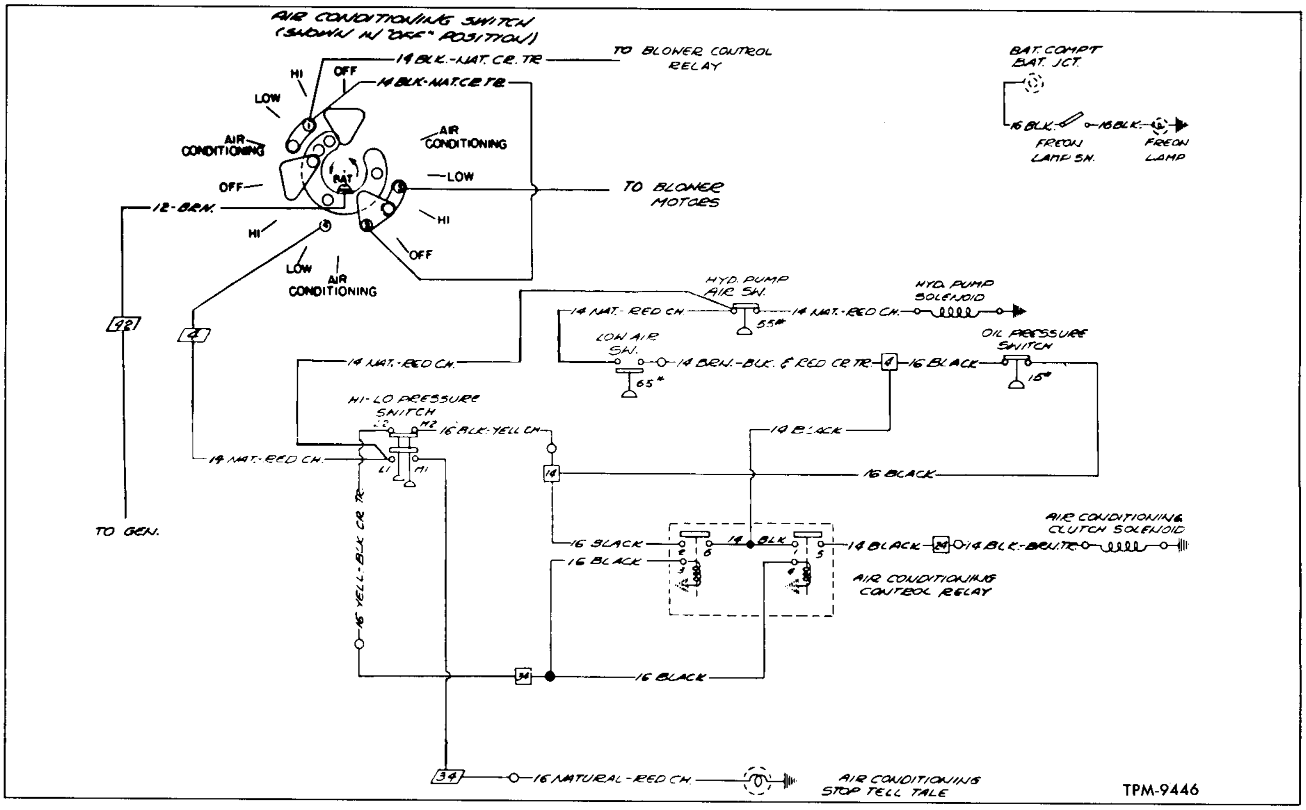


Figure 3—Simplified Schematic Wiring Diagram

2. The engine must be running at idle speed, and the air pressure in coach air system must be more than 65 psi to close low air pressure switch before circuit through the refrigerant "HI-LO" pressure switch is completed to operating coils of air conditioning control relay. Relay is located in engine electrical compartment. With relay operating coils energized, contacts close and circuit is completed to the air conditioning drive clutch solenoid valve. Solenoid valve is located in compressor compartment.

3. Air conditioning control relay is a lock-in type unit; that is, after operating coils are energized and contacts close, contacts will remain closed as long as the circuit through the contacts is not broken. Either of five conditions can break the circuit and cause relay contacts to open:

a. Too high or low refrigerant pressure.
b. Coach engine stops running.
c. Generator system fails.
d. Low air pressure (below 65 psi).
e. "VENTILATION" switch not in "AIR CONDITION" position.

4. The purpose of the lock-in feature of the air conditioning drive control relay is to maintain circuit to air conditioning clutch solenoid valve after the oil pressure safety switch opens. Oil pressure safety switch opens at 15 psi oil pressure (approximately 600 engine rpm). Purpose of this switch is to prevent engagement of air conditioning compressor drive clutch, if driver should turn control switch to "AIR CONDITION" position with engine running at 600 rpm or more.

5. On models without air conditioning, engine idle speed is set at 400 rpm. With air conditioning idle speed is set at 465 rpm.

FUNDAMENTAL PRINCIPLES OF REFRIGERATION

The principle of operation of the refrigeration system is based on a few simple laws of physics which are stated informally as follows:

1. Temperature is a measurement of the intensity of heat.

2. Heat is a form of energy. When heat is added to a substance, it usually is noticed by an increase in temperature. For example, in order to raise the temperature of water from 35°F. to 100°F., it is necessary to add a certain amount of heat.

3. When an object cools, it does not absorb cold, but rather it loses heat to a colder object or substance nearby. When a bottle containing warm liquid is placed on a cake of ice, the ice will melt and the bottle and its contents will become cool. Heat from the bottle and its contents is lost to the ice.

4. When a liquid boils, turning to vapor, it absorbs a great amount of heat. For instance, water boiling on a stove is absorbing a great amount of heat from the burner as it is changing to the vapor commonly called steam. Boiling is a rapid form of evaporation.

When a liquid boils, it absorbs heat without changing temperature. For example, when heat is added to water at sea level, as when heating on a stove, the temperature of the water will rise until it reaches 212°F. If the water remains on the hot stove, it will boil, but the temperature will remain at 212°F. The heat being absorbed by the water is changing it to steam rather than raising the temperature.

Refrigerant-22 used in air conditioning system, boils at 41.7°F. below zero. Thus, if it were exposed to the air at normal room temperature, it would absorb heat from surrounding air and boil, immediately changing to a vapor.

5. When heat is removed from this water vapor, it will condense back into a liquid. For example, the steam caused by boiling water on a stove will condense into water on the underside of the cover. This is due to the fact that the cover is not as hot as the steam. The cover, therefore, takes heat from the steam, causing it to condense back to water.

6. The temperature at which substances will boil or condense is affected by pressure. If the pressure is increased, the liquid will not boil until a higher temperature is reached. Thus, we can prevent refrigerant from boiling if it is kept under high pressure. If this high pressure is suddenly released, refrigerant will immediately boil. This has been demonstrated in modern vehicles with pressure cooling systems.

When the pressure of a vapor is increased, the temperature at which it will condense is also raised. Steam condenses at 212°F., if heat is removed from it, but it can be made to condense at higher temperature by increasing the pressure.

7. Compressing a vapor increases its temperature. For example, when pumping air into a tire with hand pump, the pump will become warm due to the heating of the air as it is compressed.

8. When a liquid is heated until it is converted to a gas, then this gas is heated additionally without changing pressure, the gas is said to be superheated. For instance, in the evaporator refrigerant absorbs heat and boils at a constant temperature and pressure until it has been completely vaporized, and it continues to absorb heat from the warm air passing over the evaporator without any increase in pressure. Since this heat is no longer being used to convert the refrigerant from a liquid to a gas, it will now cause the temperature of the refrigerant gas to rise. The refrigerant is then superheated.

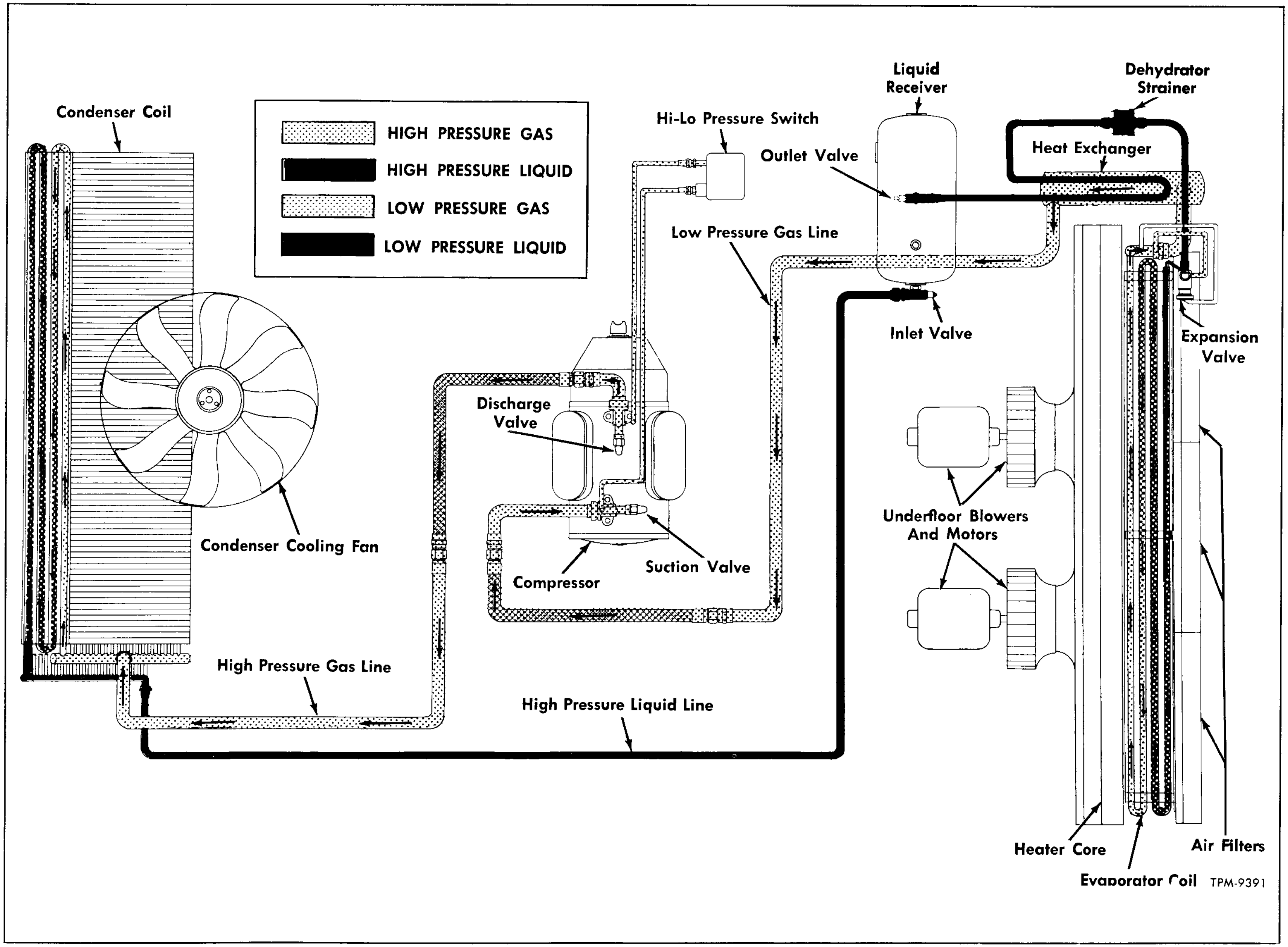


Figure 4—Schematic of Refrigerant Controls and Lines Showing High and Low Pressures

REFRIGERANT

The refrigerants used are commonly known by their trade name of Freon-22, Isotron-22, or Genetron-22. Regardless of brand, refrigerant-22 must be used. The chemical name of refrigerant-22 is monochlorodifluoromethane ($CHClF_2$).

REFRIGERANT CHARACTERISTICS

Refrigerant exists as a gas at atmospheric pressure and must be held under pressure to remain liquid. At ordinary temperatures, it will exist as a liquid under a pressure of about 75 pounds per square inch.

Refrigerant has very little odor, but in large concentrations a distinct odor may be detected. It is colorless in both its liquid and gaseous states.

Refrigerant is nonpoisonous, nonflammable, and nonexplosive. It is noncorrosive to any of the ordinary metals.

Goggles should be worn whenever there is the slightest possibility of refrigerant coming in contact with the face or eyes, because refrigerant evaporates and cools so rapidly it will cause an injury similar to frostbite.

PROCUREMENT

Refrigerant is shipped and stored in metal drums. It is serviced in one size, a 22 lb. drum.

It will be impossible to draw all the refrigerant out of the drum. The use of warm water when charging the system will assure the extraction of a maximum amount of refrigerant from the drum. Be sure to follow the instructions under "Charging The System" explained later.

PRECAUTIONS IN HANDLING REFRIGERANT

1. Do not leave drum of refrigerant uncapped.
2. Do not subject drum to high temperature.
3. Do not weld or steam clean on or near system.
4. Do not fill drum completely.
5. Do not discharge vapor into area where flame is exposed.
6. Do not expose eyes to liquid.

All refrigerant drums are shipped with a heavy metal screw cap. The purpose of the cap is to protect the valve and safety plug from damage. It is good practice to replace the cap after each use of the drum for the same reason. If the drum is exposed to the radiant heat from the sun, the resultant increase in pressure may cause the safety plug to release or the drum to burst.

For the same reason, the refrigerant drum should never be subjected to excessive temperature when charging a system. The refrigerant drum should be heated for charging purposes by placing in 125°F. water. Never heat above 125°F. or use blowtorch, radiator, or stove to heat the drum.

Welding or steam cleaning on or near any of the refrigerant lines or components of the air conditioning system could build up dangerous and damaging pressures in the system.

If a small drum is ever filled from a large one, never fill the drum completely. Space should always be allowed above the liquid for expansion. Weighing drums before and during the transfer will determine fullness of drums.

Discharging large quantities of refrigerant into a room can usually be done safely as the vapor would produce no ill effects. However, this should not be done if the area contains a flame-producing device such as a gas heater. While refrigerant normally is nonpoisonous, heavy concentrations of it in contact with a live flame will produce a poisonous gas. The same gas will attack all bright metal surfaces.

One of the most important cautions concerns the eyes. Any liquid refrigerant which may accidentally escape is approximately 41°F. below zero. If liquid refrigerant should touch the eyes, serious damage could result. Always wear goggles to protect the eyes when opening refrigerant connections.

TREATMENT IN CASE OF INJURY

Should liquid refrigerant come in contact with the skin, injury should be treated the same as if skin were frost-bitten or frozen. Should liquid refrigerant get into the eyes, a good eye specialist should be consulted immediately. Avoid rubbing or irritating the eyes. Give the following first aid treatment as soon as possible.

1. Drops of sterile mineral oil (obtainable at any drug store) should be introduced into the eyes. The mineral oil will absorb the refrigerant.

2. Eyes should then be washed, if irritation continues at all, with one of the following:

a. A weak boric acid solution.

b. A sterile salt solution not to exceed 2% sodium chloride (table salt).

3. If irritation continues for a period longer than 12 hours, eyes should be treated for secondary infection with 10% Argyrol solution or with 1% Mercuric Oxide ointment.

REFRIGERANT CIRCULATION

Refrigerant control units and piping is illustrated in figure 4. A complete cycle of the refrigerating system is as follows:

1. Refrigerant in its gaseous state is drawn into the compressor where it is compressed and discharged into the condenser.

2. As the heated gas circulates through the condenser coils, it is cooled by air being forced through the condenser by a hydraulically-driven

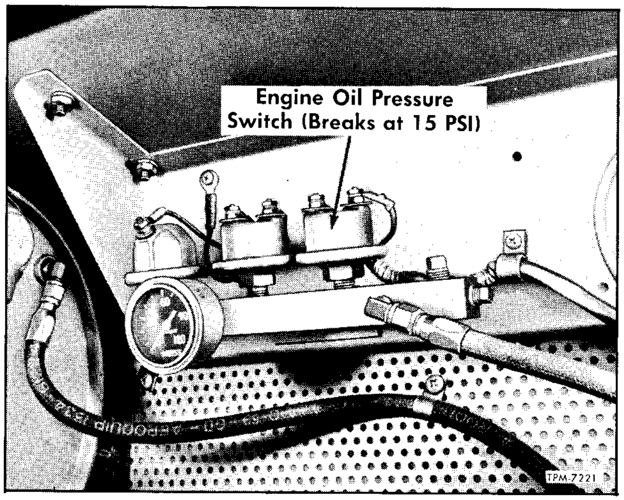


Figure 5—A/C Control Engine Oil Pressure Safety Switch Installed

fan. The combined effects of the decreased temperature and increasing pressure cause the gas to condense (liquify).

3. The liquid refrigerant is then forced from condenser into the liquid receiver.

4. By its own pressure, liquid refrigerant is forced from liquid receiver through the heat exchanger, where it is cooled somewhat by the returning suction line low pressure gas, then through the dehydrator and expansion valve into the evaporator

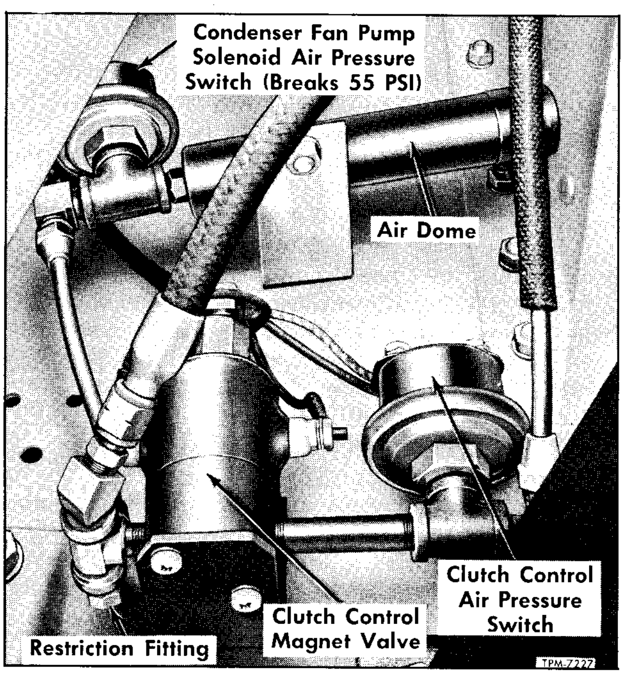


Figure 6—Clutch Control Air Solenoid Valve, Air Switches and Air Dome Installed (Typical)

5. In the evaporator, where the pressure is reduced, the liquid refrigerant evaporates, or changes into its gaseous state. As the liquid evaporates, heat is absorbed from the air passing through the evaporator coils, thus the air is cooled.

6. Flow of refrigerant into the evaporator is regulated by the expansion valve. The expansion valve is actually a pressure reducing valve which serves two purposes: a - It maintains pressure on the liquid line. b - It admits only the required amount of liquid refrigerant into the evaporator, this requirement being determined by the temperature of the gaseous refrigerant at the evaporator outlet.

7. The low pressure refrigerant gas passes from the evaporator through the heat exchanger and back through the suction line to compressor, thus completing the cycle.

NOTE: Gauges for checking pressures in the refrigerant system can usually be obtained from a local refrigeration service and supply dealer.

AIR CIRCULATION

With "VENTILATION" switch on control panel in "AIR CONDITION" position and with a minimum of 60 psi air pressure to compressor clutch control, the compressor will operate and the underfloor blowers will run continuously at high speed.

Blowers draw outside air into heating and cooling compartment through two grilled openings, one each side of coach just below windows. The outside air is blended with recirculated air which enters same heating and cooling compartment through two screened openings in the floor, one each side of aisle. This blended air is then drawn by blowers through screens where it is filtered, through evaporator coils where it is cooled and dehumidified, and then through the heater core unit where the temperature is raised to comfort level to extent determined by the control Grad-U-Stat. Tempered air then flows into coach interior through flat, wide, vertical ducts located below the windows.

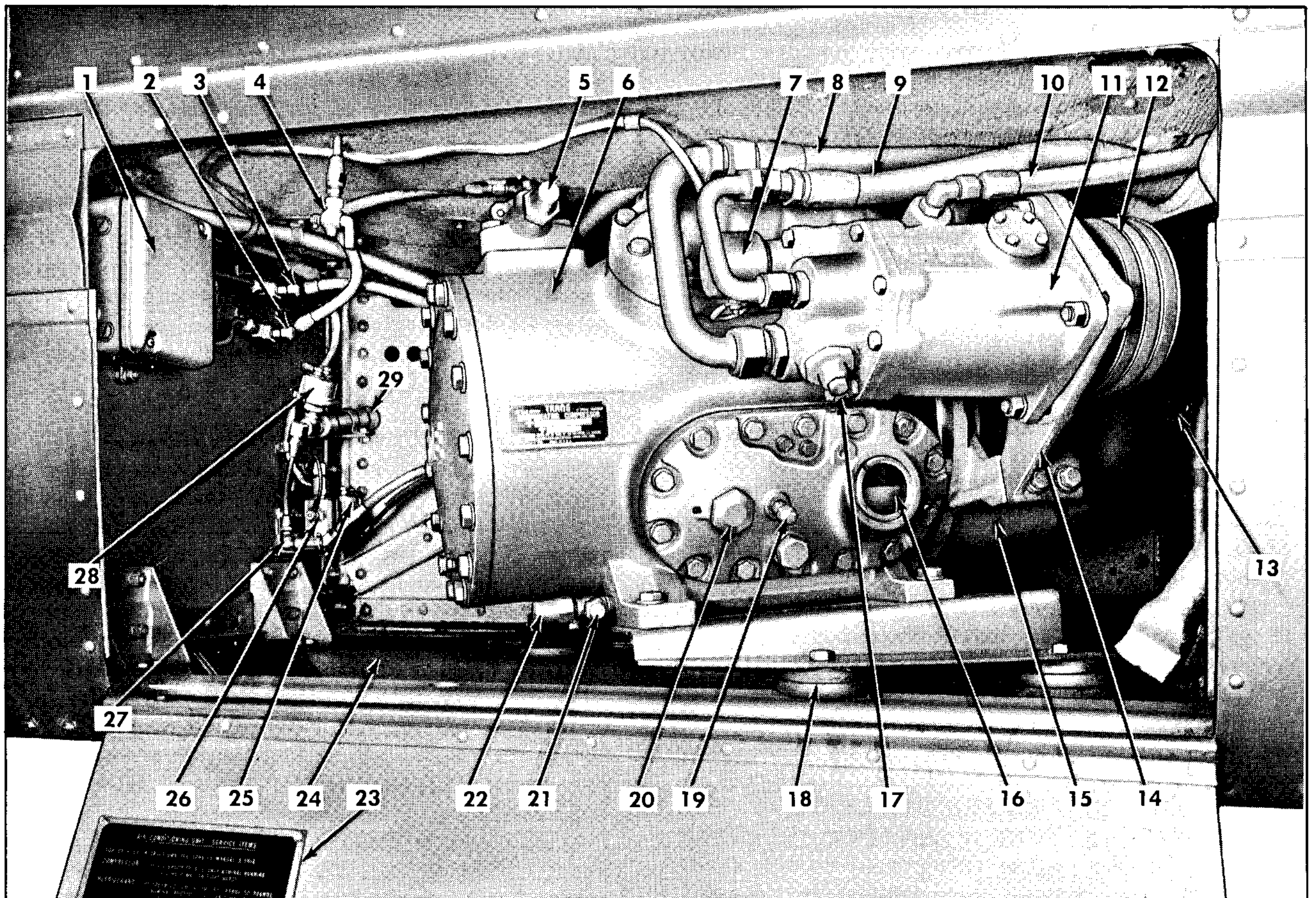
OPERATION OF ELECTRICAL CONTROL UNITS

Refer to "HEATING SYSTEM" (SEC. 3) for operating information on controls such as: Grad-U-Stat, air pressure regulating valve, blower motors, blower motor relays, water modulation valve and heating system water pump.

"VENTILATION" CONTROL SWITCH

Control switch marked "VENTILATION" on control panel at left of driver is a four-position rotary-type switch.

With switch in "AIR CONDITION" position, the circuit to underfloor blowers is energized causing



1 Refrigerant HI-LO Pressure Switch
2 Refrigerant Low Pressure Test Gauge Fitting
3 Refrigerant High Pressure Test Gauge Fitting
4 Heating System Water Line Drain Cock
5 Refrigerant Suction Valve Assy.
6 Refrigerant Compressor Assy.
7 Pump Solenoid Assy.
8 Fan Drive Low Pressure Return Line
9 Fan Drive High Pressure Supply Line
10 Fan Drive Vent Line
11 Fan Drive Pump Assy.
12 Fan Drive Pump Drive Belts
13 Compressor Drive Shaft Assy.
14 Fan Drive Pump Mounting Bracket
15 Compressor Clutch Unit
16 Compressor Oil Level Sight Glass
17 Compressor Fan Speed Control
18 Compressor Mounting Cushion Assy.
19 Compressor Oil Pressure Test Fitting
20 Compressor Cylinder Unloading Valve Adjustment
21 Compressor Oil Drain Valve Line Protector Cap
22 Compressor Oil Drain Valve Stem Protector Cap
23 Service Instruction Plate
24 Compressor Mounting Platform
25 Clutch Control Air Pressure Switch Assy.
26 Clutch Control Air Solenoid Valve Assy.
27 Restriction Fitting
28 Condenser Fan Drive Pump Air Pressure Switch
29 Air Dome

TPM-7222

Figure 7—Refrigerant Compressor Compartment (Typical)

them to operate at high speed, and circuit is completed through the "HI-LO" refrigerant pressure switch. Circuits are shown in figure 3.

AIR CONDITIONING CONTROL RELAY

Air conditioning drive control relay is located in the apparatus box at right rear of coach as shown in figure 5 in "WIRING AND MISCELLANEOUS ELECTRICAL" (SEC. 7).

Relay serves to close electrical circuit to compressor drive clutch air solenoid valve causing valve to open, allowing air pressure to clutch.

Relay is a lock-in type unit; that is, after operating coils are energized and contacts close, contacts will remain closed as long as the circuit through the contacts is not broken. Either of five conditions can break the circuit and cause relay contacts to open:

1. Excessive high or low refrigerant pressure.
2. Engine stops running.
3. Low air pressure (below 65 psi).
4. "VENTILATION" switch not in "AIR CONDITION" position.
5. Generator system fails.

The purpose of the lock-in feature of the air conditioning control relay is to maintain circuit to air conditioning clutch solenoid valve after the oil pressure safety switch opens. Oil pressure safety switch opens at 15 psi oil pressure.

ENGINE OIL PRESSURE SAFETY SWITCH

Engine oil pressure safety switch is mounted in manifold on engine bulkhead (fig. 5).

With engine running and oil pressure at 15 psi or more, contacts of safety switch are opened. Purpose of switch is to prevent engagement of air conditioning compressor drive clutch if driver should turn control switch to "AIR CONDITION" position with engine running above 600 rpm.

CLUTCH CONTROL AIR PRESSURE SWITCH

Air pressure switch is mounted at left end of bulkhead forward of the refrigerant compressor (fig. 6). Purpose of switch is to prevent compressor drive clutch slippage which could be caused by insufficient operating air pressure.

Contacts of switch close when the air pressure in coach air system exceeds 65 psi. Switch completes circuit from No. 4 terminal of "VENTILATION" switch on control panel at left of driver, through the engine oil pressure safety switch, the refrigerant "HI-LO" pressure switch, and to the air conditioning control relay as shown in figure 3.

COMPRESSOR DRIVE CLUTCH AIR SOLENOID VALVE

Compressor drive clutch solenoid valve (fig. 6) is mounted on bulkhead forward of the refrigerant compressor.

Air valve is an electrically-operated valve which controls flow of air pressure for the operation of compressor drive clutch. Circuit to valve is controlled by the air conditioning control relay mounted in apparatus box at right rear of coach.

With valve coil energized, air pressure is permitted to pass through valve and flexible line to engage the compressor clutch mechanism. When valve is de-energized by action of control relay, air pressure is exhausted from clutch drive mechanism to disengage clutch.

"HI-LO" REFRIGERANT PRESSURE SWITCH

Definite high and low refrigerant pressures are established at which the system will operate efficiently and safely. "HI-LO" pressure cutout switch is provided to prevent operation of system when pressures exceed these limits. The switch is located in compressor compartment. On all models 4501, 4516, and 4517, switch is located on side of compressor, whereas on all models 5301 and 5302, the switch is mounted to bulkhead forward of compressor as typically shown in figure 7. Switch is connected to high and low refrigerant pressures at the compressor. Current from "VENTILATION" switch is routed through the "HI-LO" pressure switch. Whenever the high or low refrigerant pressure exceeds limits, switch interrupts compressor clutch controls to stop compressor. When this occurs, another set of contacts within control relay close to complete circuit from "VENTILATION" control switch to the A/C stop telltale on driver's panel. Telltale, when illuminated indicates that compressor is not operating. When refrigerant pressures normalize to the switch cut-in point, compressor clutch control circuit is again completed and the compressor becomes operative.

Switch adjustment procedures are explained later under "SYSTEM MAINTENANCE" - See "Refrigerant HI-LO Pressure Switch."

NOTE: Other than the fundamental principles of refrigeration which are the same in most conventional refrigeration systems, the control and "reheat" phase of system as used on GM Coaches is relatively new to the field. Therefore, a thorough knowledge of the system and service procedures by maintenance personnel will assure long and efficient operation of air conditioning system.

System Maintenance

CONTENTS OF THIS SECTION

HI-LO PRESSURE SWITCH

The HI-LO pressure switch (fig. 8) is a dual pressure control switch connected in series with the air conditioning control circuit, and actuated by the high side and low side refrigerant pressures. The control unit consists basically of two bellows, both of which are connected through spring-loaded toggle linkage to a set of contact points, all enclosed within a dust-proof case.

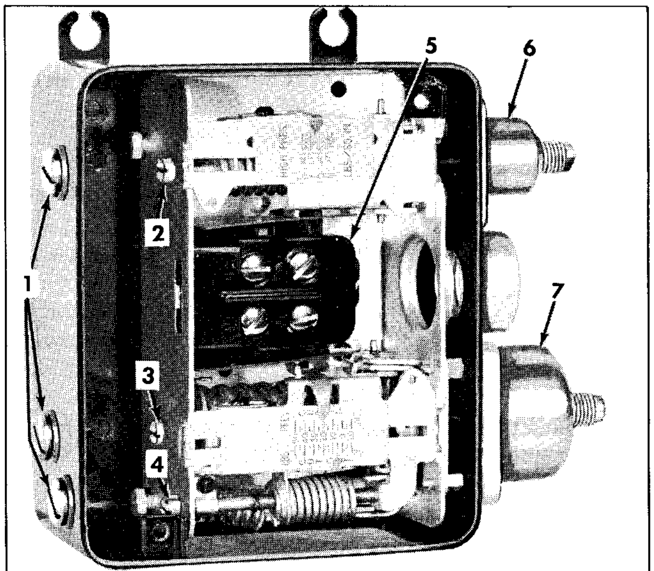
Low pressure cut-out and cut-in points are adjustable; high pressure cutout point is adjustable but the differential on the high pressure side of switch is fixed and nonadjustable. Openings are provided in side of case to permit making adjustments with a straight screwdriver.

All four wire terminals, L1, L2, M1, and M2 are used on this installation. Either of the two bellows assemblies and the contact assembly are replaceable. When connecting lines to either bellows, it is extremely important to use a wrench on hex portion of bellows element while tightening hose fitting to prevent damaging bellows.

The HI-LO pressure cut-out switch is properly set at the factory and should not normally require adjustment in the field. However, in the event of improper operation, switch operation can be tested and adjusted, if necessary, as follows:

LOW PRESSURE TEST AND ADJUSTMENT

Low pressure cut-out is an extremely important adjustment. System will not function satisfactorily and possible damage to compressor may result if switch points fail to open near the designated pressure. In making the following test, an accurate compound (pressure and vacuum) gauge should be used. Gauge set can be obtained from local refrigeration sales and service dealer.

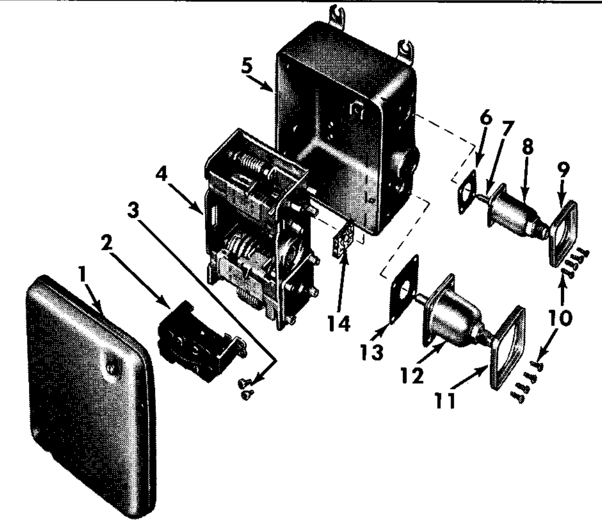


1 Access Plugs
2 High Pressure Cut-out Adjustment
3 Low Pressure Range Adjustment
4 Low Pressure Cut-out Adjustment
5 Contact Assembly
6 High Pressure Bellows
7 Low Pressure Bellows

TPM-1325

Figure 8—Refrigerant Hi-Lo Pressure Switch

SYSTEM MAINTENANCE



1 Cover and Seal Assy.	9 Bellows Retainer
2 Switch Contact Assy.	10 Attaching Screws
3 Attaching Screws	11 Bellows Retainer
4 Switch Actuating Assy.	12 Low Pressure Bellows Assy.
5 Switch Box	13 Gasket
6 Gasket	14 Anti-rattle Pad
7 Plunger Shaft	
8 High Pressure Bellows Assy.	

TPM-9453

Figure 9—Exploded View of Hi-Lo Pressure Switch

1. Remove cap from suction pressure line test gauge fitting (2, fig. 7); then connect pressure gauge line to valve. Have an assistant close suction valve slowly on top side of compressor by turning valve stem in (clockwise) until valve seats.

2. Start coach engine and operate compressor, then observe pressure reading on gauge at the instant compressor clutch becomes disengaged and compressor stops. Switch points should open to disengage clutch at 10 psi gauge pressure.

3. Next allow pressure to build up until compressor clutch becomes engaged. Pressure reading on gauge when switch points close and complete circuit to compressor clutch drive should be 30 psi.

4. If switch points do not open and close at gauge readings specified in Steps 2 and 3, adjust as follows:

a. Remove switch cover, and remove adjusting hole plugs from case.

b. If only the cut-out point requires adjustment, turn adjusting screw (4, fig. 8). Indicator is calibrated in increments of 5 psi.

c. If the cut-in point requires adjustment, turn adjusting screw "3," which changes the cut-in and cut-out points an equal amount, then re-adjust cut-out point by turning screw "4."

d. After adjusting, recheck operation of unit, then open suction valve at top of compressor.

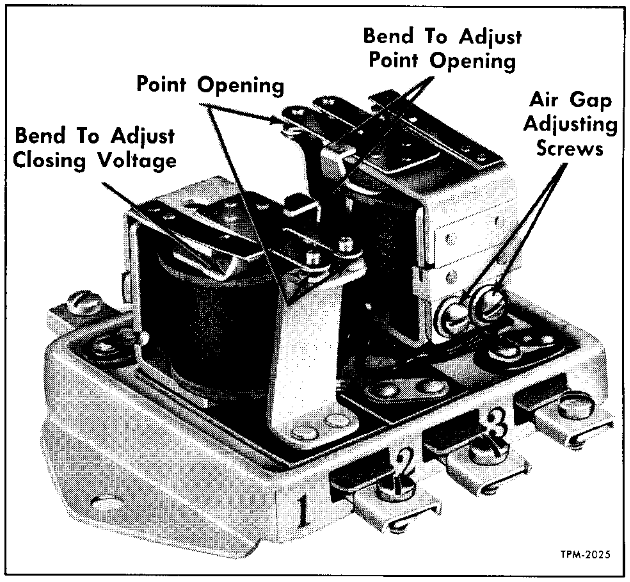


Figure 10—Air Conditioning Control Relay

HIGH PRESSURE TEST AND ADJUSTMENT

The high pressure side of the switch should open the points and disengage the compressor clutch at 375 psi gauge pressure, and should permit the points to close when pressure drops to 300 psi. The point at which the switch cuts out is adjustable, but the cut-in point is not adjustable. Test switch and adjust if necessary as follows, using an accurate high pressure gauge:

1. Remove cap from discharge pressure line test gauge fitting (3, fig. 7), then connect pressure gauge line to valve.

2. With both the suction and discharge valves in operating position (cracked 1/2 to 1 turn away from backseated position), operate compressor. Have an assistant slowly close the discharge valve by turning valve stem clockwise and observe pressure reading on gauge the instant the compressor stops. If gauge reading when compressor stops is more or less than 375 psi, adjust by turning adjusting screw (2, fig. 8).

CAUTION: If high pressure switch fails to disengage compressor clutch when pressure reaches 400 psi, stop engine, as pressures in excess of this amount may damage other units.

3. Have assistant open discharge valve, then repeat test 2 above to recheck cut-out adjustment.

4. When pressure cut-out switch stops the compressor at correct pressure, continue to operate coach engine and air conditioning system until pressures equalize, then observe reading on pressure gauge when circuit is completed to compressor clutch drive. If switch does not permit points to close at 300 psi gauge pressure, the complete control unit should be replaced.

5. After completing tests and adjustments, install cover and install access plugs in case.

PRESSURE SWITCH ASSEMBLY REPLACEMENT

1. Pump down system as directed later under "SYSTEM SERVICES AND TESTS."

2. Disconnect refrigerant pressure lines at switch and immediately cap lines to seal moisture and air from system.

3. Reverse the above procedure to install pressure switch.

4. After installing switch assembly, place system back in operating position, then vent or crack line connections at switch. Tighten connections firmly after venting.

PRESSURE SWITCH BELLOWS AND CONTACT REPLACEMENT

NOTE: Three subassemblies of HI-LO pressure switch are available for service; the high and low pressure bellows (8 and 12, fig. 9), and the switch contact (2, fig. 9). The following describes replacement procedure of above mentioned parts. Bellows should be replaced if refrigerant is leaking into switch box, which may be due to a broken diaphragm within bellows. The switch contact unit should be replaced if arcing is noted when switch contacts open and close, or if current flow check indicates failure of current to pass through switch.

Disassembly

NOTE: Key numbers in text refer to figure 9.

1. Remove four screws (10) which attach high and low pressure bellows (8 and 12) to switch box (5). Remove bellows retainers (9 and 11), the bellows, and gaskets (6 and 13).

NOTE: Be careful not to lose plunger shaft (7) from inside of high pressure bellows (8).

2. Remove cover (1) with cover seal from switch box.

3. To remove the switch contact assembly (2), remove two small screws (3) which attach contact mounting bracket to switch box. Lift switch contact assembly from box.

Installation

NOTE: Key numbers in text refer to figure 9.

1. Attach switch contact assembly (2) to box with two small screws (3). Tighten screws firmly.

2. NOTE: On later coaches, a square shape soft rubber pad (14) is located between switch box and switch actuator assembly (4) at the high pressure bellows. Bellows plunger shaft (7) must be inserted through hole in pad when installed.

3. Install high and low pressure bellows (8 and 12), gaskets (6 and 13), and retainers (9 and 11) with small screws (10). Tighten screws firmly.

IMPORTANT: Cap openings of bellows line fittings until such time switch assembly is installed.

AIR CONDITIONING CONTROL RELAY

Air conditioning control relay, mounted on electrical panel at right rear of coach, controls the compressor clutch solenoid valve. Relay installed is shown in figure 5 of WIRING AND MISCELLANEOUS ELECTRICAL (SEC. 7). Figure 10 shows relay with cover removed.

Terminal No. 2 is fed through both air conditioning control engine oil pressure switch and the 65 psi air pressure switch from the "VENTILATION" control switch located on panel at left of driver when switch is in "AIR CONDITION" position.

Terminal Nos. 1 and 6 are fed by same circuit except that circuit does not flow through the engine oil pressure switch.

Terminals Nos. 3 and 4 are connected to relay operating coils. Terminals are fed from the No. 2 terminal of relay after current flows through closed contacts of first the low air pressure switch and then the refrigerant HI-LO pressure switch.

Relay circuits are shown on figure 3 or on Wiring Diagram in back of this manual. Terminal identification numbers shown on Wiring Diagram are stamped on base of relay at side of terminals. Relay adjustment points are shown in figure 10.

RELAY ADJUSTMENTS

Air Gap (Fig. 10)

Disconnect wires from terminal Nos. 2 and 5 and remove cover from relay. Press armature down until points just close, then measure air gap between armature and center of core. Air gap should be 0.014". Adjust air gap, if necessary, by loosening two screws and moving armature up or down as required.

Point Opening (Fig. 10)

With wires still disconnected from terminal Nos. 2 and 5, measure clearance between points with armature up against stop. Clearance should measure 0.028". Adjust point opening, if necessary, by bending the armature stop. Make sure opening at both points are equal and that points close simultaneously when armature is depressed. After completing adjustment, connect wires to terminal Nos. 2 and 5.

Closing and Opening Voltage (Fig. 10)

Check each unit separately by connecting an accurate reading voltmeter parallel with each operating coil circuit. Connect voltmeter from No. 3 terminal to ground for one unit and from No. 4 terminal to ground for the other unit. Also connect a variable resistance unit in series with the operating coil circuit at the same terminal to which the

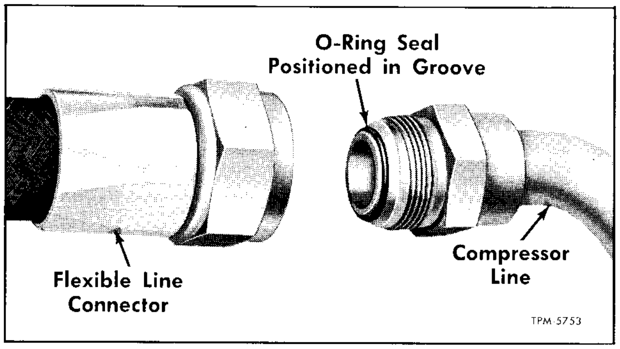


Figure 11—Refrigerant Line O-Ring Seal Installed

voltmeter is connected. Close the switch which controls the operating coil circuit of the unit being checked. Slowly decrease resistance and note voltmeter reading when points close. Points should close between 8.5 to 10.5 volts. If not within the range adjust by bending the armature spring post. Increase spring tension to increase closing voltage and decrease spring tension to decrease the closing voltage. After correct closing voltage adjustment is obtained, slowly increase resistance and note voltmeter reading when points open. If opening voltage is below 4.3 or if either unit fails to operate, replace the complete relay assembly.

REFRIGERANT CONNECTIONS

THREADED CONNECTIONS

A rubber O-ring seal (fig. 11) is used at line threaded connections to assure positive seal. Break line connection using two wrenches as shown in figure 12. After breaking connection, remove old O-ring seal and install new seal in seal groove.

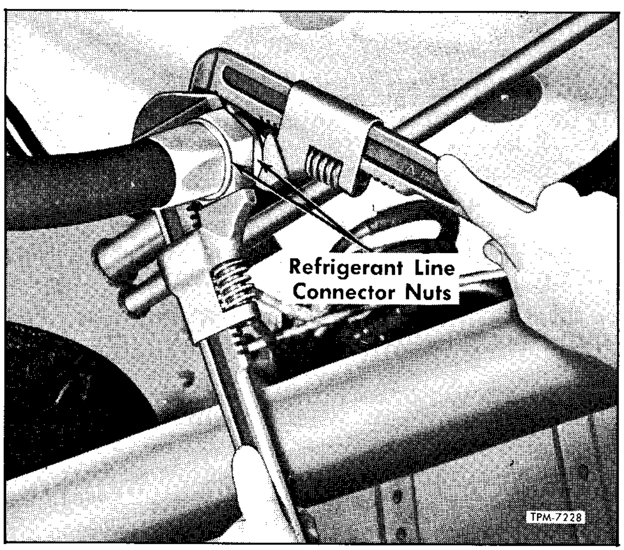


Figure 12—Using Two Wrenches At Line Connection

Before line is connected, apply clean compressor oil to O-ring seal to facilitate connection. Tighten line nut firmly. Check for leaks as explained later under "SYSTEM SERVICES AND TESTS."

SOLDERED JOINTS

Clean surfaces to be soldered using No. 00 steel wool, then apply thin coat of "Nokorode" flux. Sweat connection with special 95% tin and 5% antimony solder.

> IMPORTANT: Use GM replacement rubber lines - type 2603 or a brand of equal quality. When replacing any connection, either threaded or soldered, DO NOT use cast fittings - due to the porosity of castings, refrigerant gas will leak through the pores.

CLUTCH CONTROL AIR SOLENOID VALVE

Solenoid valve assembly is constructed as shown in figure 13. Foreign substances, present in compressed air system, may enter solenoid valve and injure valve faces and seats sufficiently to permit air leakage past valve rubber inserts when valves are seated. This condition may be detected easily on vehicle or on bench by testing valve ports with soap suds.

Valve assembly can be readily disassembled for cleaning, inspection, and replacement of parts.

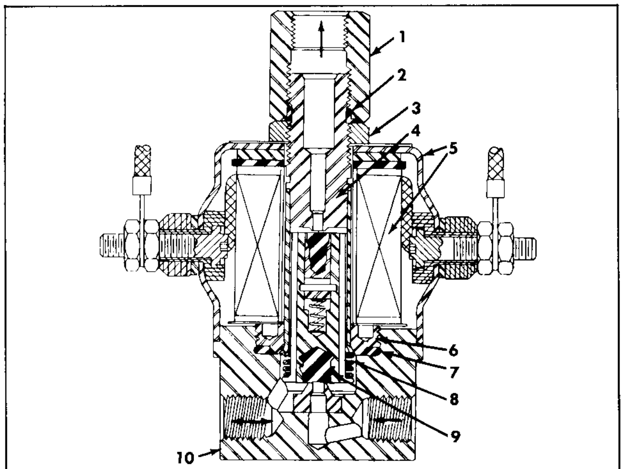
DISASSEMBLY

NOTE: Key numbers in text refer to figure 13.

1. Remove threaded adapter (1) and seal (2) from sleeve assembly (4), then remove thin nut (3) which retains housing and coil assembly (5) to sleeve assembly.
2. Remove housing and coil assembly (5) by sliding off upper end of sleeve assembly.
3. Using special spanner wrench (skinner No. VO-233), unscrew sleeve retaining nut (6) from valve body (10), then remove sleeve assembly (4), plunger assembly (9), and plunger spring (8) from valve body.
4. Remove sleeve nut seal (7) from valve body. Discard seals (2 and 7) and obtain new parts for assembly.

CLEANING AND INSPECTION

Wipe all parts clean with a clean cloth. Do not clean housing and coil assembly or plunger assembly in cleaning solvent. Examine rubber inserts in plunger assembly for wear or deterioration. Replace plunger assembly if damaged. Make sure valve seats on sleeve and in body are clean and smooth.



1 Adapter
2 Adapter Seal
3 Thin Hex Nut
4 Sleeve Assembly
5 Housing and Coil Assy.
6 Sleeve Retaining Nut
7 Sleeve Nut Seal
8 Plunger Spring
9 Plunger Assembly
10 Valve Body TPM-5756

Figure 13—Clutch Control Air Solenoid Valve

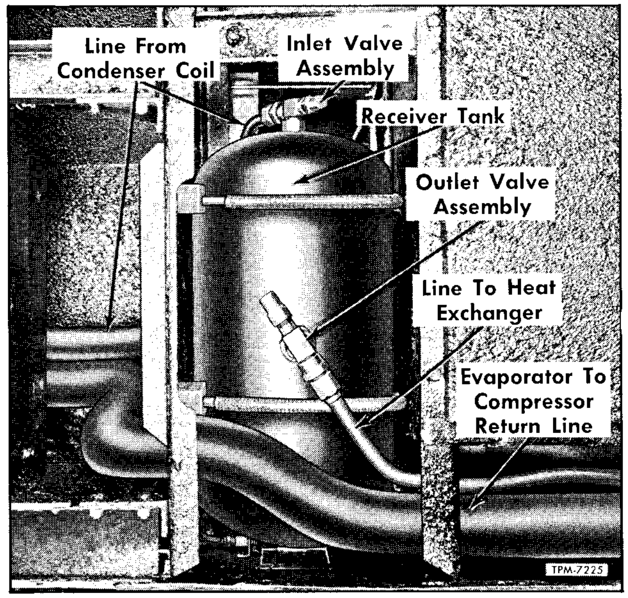


Figure 14—Refrigerant Receiver Tank Installed

ASSEMBLY

NOTE: Key numbers in text refer to figure 13.

1. Assemble plunger spring (8) on plunger assembly (9) and position plunger in valve body.

2. Place new seal (7) in body, then install sleeve assembly (4) in body and secure with sleeve retaining nut (6). Use special spanner wrench to tighten sleeve nut.

3. Install housing and coil assembly (5) over sleeve, then install thin nut (3). Tighten nut only as necessary to seat parts solidly; overtightening will place excessive strain on sleeve assembly.

4. Place new seal (2) in groove of adapter, then install adapter (1) on sleeve. Hold nut (3) while tightening adapter.

LIQUID REFRIGERANT RECEIVER TANK

Liquid receiver (fig. 14) serves as a reservoir for a constant supply of liquid refrigerant ready for use in the evaporator. Two sight glasses are provided at left end of receiver; one in end of tank and one in side of tank. A light bulb, installed over side sight glass is illuminated by operating switch located inside of sight glass access door. With light on, level of refrigerant can be readily seen in end sight glass. After unit has been running for 30 minutes or more, refrigerant level should be at center of end sight glass. In no case should the refrigerant level be above the sight glass or below it with the system operating. Refrigerant can be added to the system at the compressor suction valve line to pressure switch test gauge fitting or at charging valve in line at rear of dehydrator-strainer assembly, as directed in "SYSTEM SERVICES AND TESTS" later.

During operation of the system, both the receiver inlet and outlet valves must be fully open. To determine if valves are fully open, remove valve stem caps and turn valve stems counterclockwise to the limit of their travel. If air conditioning system fails to function, receiver valves

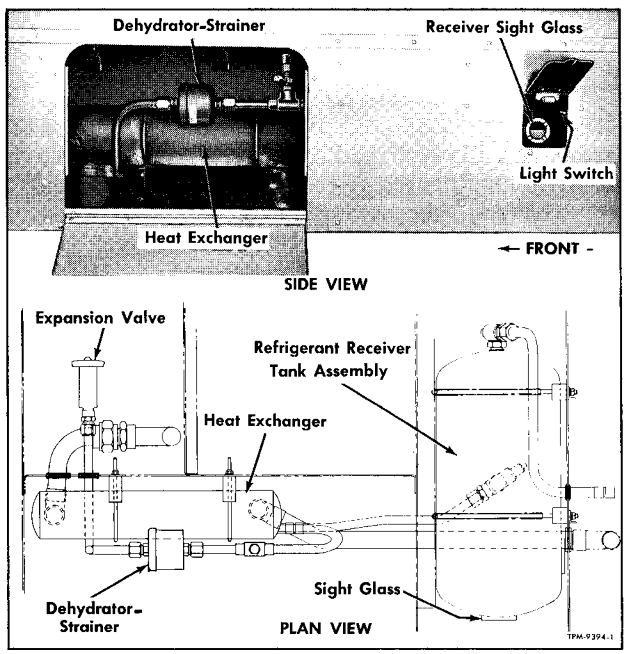


Figure 15—Dehydrator-Strainer, Heat Exchanger, Charging Valve, and Receiver Tank Sight Glass Location

SYSTEM MAINTENANCE

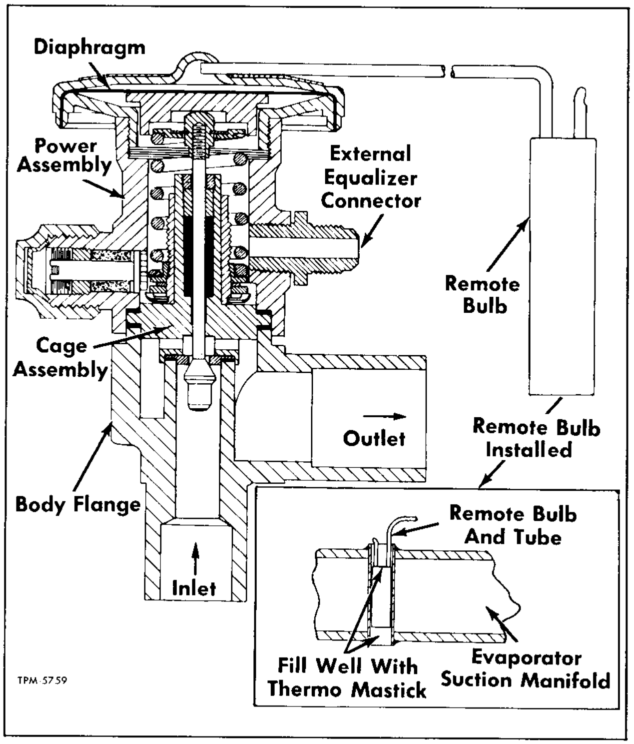


Figure 16—Sectional View of Expansion Valve

should be the first place to check. The system positively will not function unless both of the receiver valves are open. A fusible safety plug (212°F.) is installed in top of receiver tank.

REFRIGERANT DEHYDRATOR—STRAINER

The refrigerant dehydrator-strainer, installed in the liquid line at left side of coach (fig. 15), removes foreign matter and moisture from the refrigerant before it reaches the expansion valve.

Strainer is of the disposable type, charged with activated alumina. The complete unit is discarded and replaced with a new unit.

Chemical used in unit has a high moisture absorbing capacity. Any moisture which has been inadvertently admitted into system will be absorbed by the chemical. This does not mean that the system should not be evacuated when air and moisture has been admitted.

Whenever the system has been opened for any reason, the dehydrator-strainer should be again replaced after a few hours of operation. Also, it is recommended that unit be replaced at beginning of air conditioning season; when the system has been inoperative during winter operation, and after every six months of air conditioning operation.

Instructions for replacing unit are explained later in this group under "SYSTEM SERVICES AND TESTS."

EXPANSION VALVE

Expansion valve (fig. 16) is installed in the underfloor compartment at left end of evaporator coil as shown in figure 17. Valve is accessible for servicing or replacement only after the evaporator coil is removed. Expansion valve is set at the factory to provide the most efficient operation of the system, and should not normally require adjustment in the field. However, in the event a new evaporator coil and valve assembly or a new expansion valve power or cage assembly is installed, valve must be adjusted to provide the correct superheat at the evaporator outlet. In any event, do not adjust the expansion valve to compensate for insufficient cooling until all other possible causes are checked for and corrected.

EXPANSION VALVE OPERATION

Expansion valve is a manifold type thermo valve with external remote control bulb and external equalizer. Expansion valve regulates the flow of liquid refrigerant into the evaporator coils. Valve is primarily operated by the temperature of the suction gas leaving the evaporator, and is further controlled by the pressure in the evaporator through the equalizer tube. The combined effect of these two factors automatically control the quantity of liquid admitted into the evaporator. See figure 18, which shows schematic view of valve operation.

Outlet end of valve is of manifold type, which is connected by several small distributor tubes to the evaporator coils. Liquid line is connected to inlet port which extends through the center of the body flange. The remote bulb is inserted into the hollow end of the evaporator coil outlet manifold, where it is subjected to the temperature of the suction gas as it leaves the evaporator. Bulb is charged with gas refrigerant which expands and contracts in accordance with the temperature of the suction gas. Expansion of refrigerant in bulb applies pressure against diaphragm in valve power assembly, causing valve to open.

Bulb tends to operate valve toward its open or closed position to regulate the flow of refrigerant into the evaporator as required. If too much liquid is admitted into the evaporator, all of it does not evaporate and some liquid approaches the remote bulb, lowering its temperature. This will cause the liquid in the bulb to contract, relieving pressure on diaphragm, and spring moves valve toward its closed position. If there is not enough liquid in the evaporator, the resulting increase in temperature of the suction gas raises temperature of bulb, causing valve to operate in its opening direction.

EXTERNAL EQUALIZER

The purpose of the equalizer is to prevent flooding the evaporator coils when temperature of

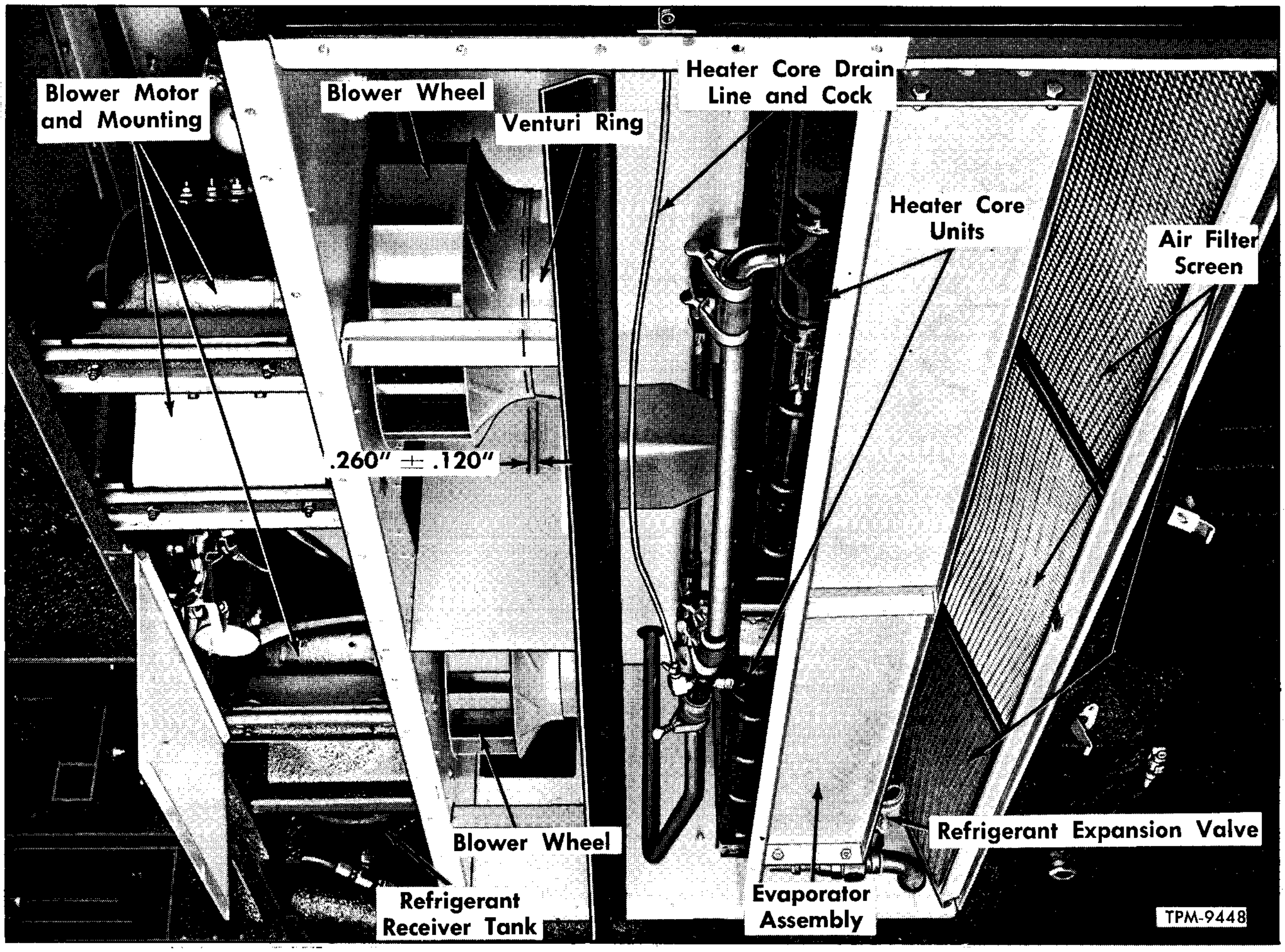


Figure 17—Cooling and Heating Compartment Closure Panels Removed

evaporator suddenly rises. Equalizer tube is connected into the evaporator coil outlet manifold and to the cavity below the diaphragm in the valve power assembly. Thus, when valve is suddenly opened wide by a high temperature in the suction gas, the heavy flow of liquid into the evaporator creates a high pressure which is carried to the underside of the diaphragm through the equalizer tube. This pressure below the diaphragm counteracts the pressure from the remote bulb and tends to move the valve toward its closed position.

CONSTRUCTION (Fig. 16)

The expansion valve has three basic component parts: The power assembly, cage assembly, and body flange. There are no working parts in the body flange. The outlet body flange is soldered to evaporator by tubes and a tube distribution manifold. Power assembly and cage assembly can be removed from the body flange without breaking any soldered connections.

Always make sure the system is clean and dry before installing the expansion valve.

SUPERHEAT

Superheat is the temperature increase of a gas, above the saturation point. When the liquid refrigerant boils or evaporates in the evaporator, heat is absorbed from the air passing through the evaporator coils, but the temperature of the gas does not rise above the boiling point until all the liquid has changed to gas. The heat thus absorbed is the latent heat of vaporization, producing a change in state with no change in temperature.

After the refrigerant has changed to gas, the temperature of the gas is still lower than the temperature of the air passing through the evaporator, so the gas will continue to absorb heat from the air and its temperature will rise a few degrees. This amount of rise above the saturation temperature is called "superheat."

Example: At 69 psi gauge pressure, the saturation temperature of refrigerant is 40^{o}F.; that is, the liquid changes to gas at 40^{o}F. If the temperature of the refrigerant gas at 69 psi gauge pressure is 48^{o}F., the gas contains 8^{o}F., of superheat. Superheating takes place after all the liquid

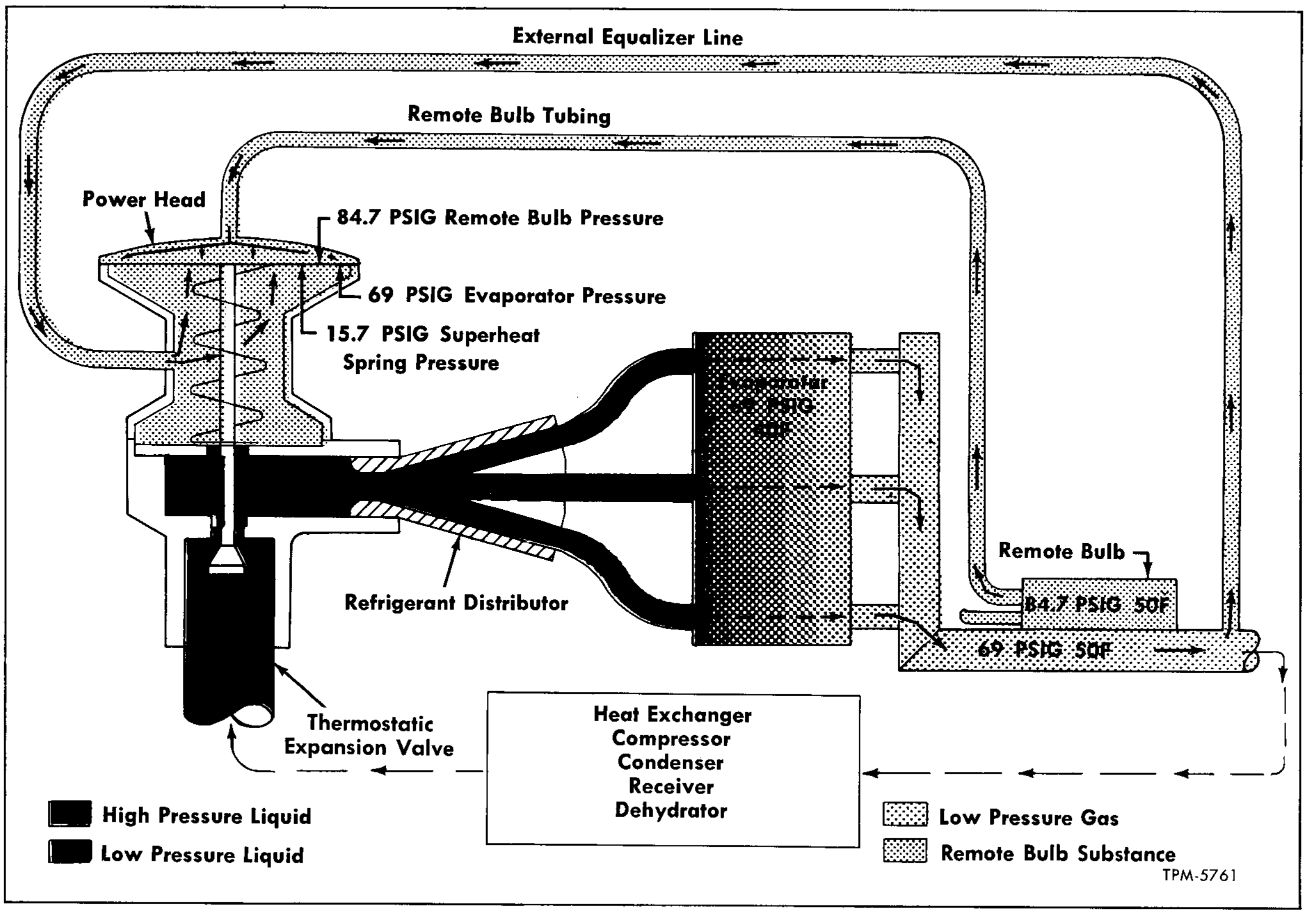


Figure 18—Simplified Diagram of Expansion Valve Operation

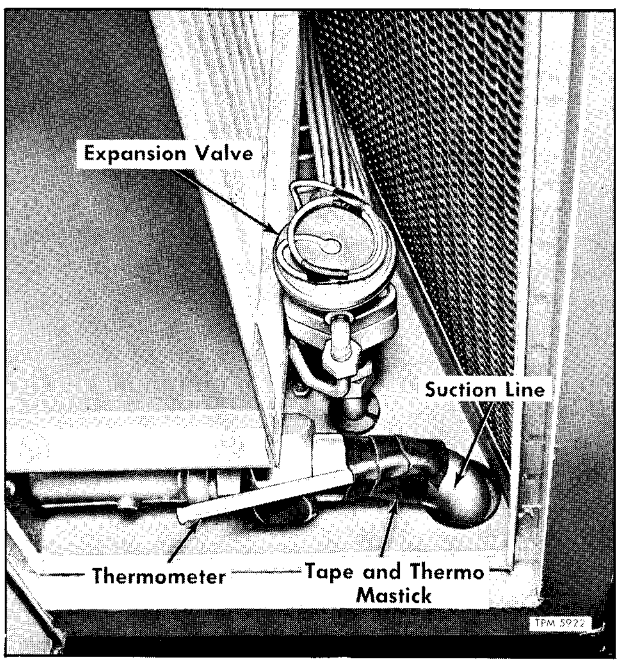


Figure 19—Checking Superheat

has changed to gas, usually near the outlet end of the evaporator coils.

PRESSURE - TEMPERATURE

Pressure has a very definite relationship to the boiling point of any substance. There is a definite temperature at which a liquid will boil for every definite pressure exerted upon that liquid. Water, which boils at 212°F. under zero gauge pressure (atmospheric pressure at sea level), will boil at approximately 232°F. under 10 psi gauge pressure.

Likewise, refrigerant boils at -41°F. (-41°F., below zero) under atmospheric pressure, and at 40°F. under 69 psi gauge pressure. An increase in pressure causes a rise in the boiling point.

The pressure temperature relationships shown in the table on page 415 are used for two purposes: for adjusting the expansion valve and for checking for air in the system. Method of checking for air in the system is described in "SYSTEM SERVICES AND TESTS" later in this group.

EXPANSION VALVE ADJUSTMENT

Valve should be adjusted to obtain 8° to 12°

superheat with moderately heavy internal load. Refer to pressure-temperature chart.

1. Apply small quantity of a thermo-type mastick to a remote-reading thermometer and attach to evaporator coil outlet, as shown in figure 19. Thermo-mastick may be available at a local refrigeration service establishment, or it can be obtained from the Alco Valve Company, St. Louis, Missouri.

2. Connect a low pressure gauge at the compressor suction valve test gauge fitting. Loosen line connection at gauge and expel air from line.

3. Compare pressure reading on gauge with temperature reading on thermometer against corresponding pressure in table. If necessary, remove cap from expansion valve adjusting stem; turn valve stem clockwise to decrease flow of refrigerant and increase superheat; turn valve stem counterclockwise to increase refrigerant flow and lower superheat. Two complete turns of valve stem will change the actuating superheat approximately $1^{o}F$.

4. After adjusting, wait about 30 minutes to check results.

5. Remove gauge and line, then install protector cap on test gauge fitting.

NOTE: If superheat is lower than recommended, check the following:

a. Batteries may be low.
b. Blower motors are operating too slow.
c. Temperature in coach may be too low.
d. Expansion valve adjustment necessary.

If superheat is higher than recommended, check the following:

a. Expansion valve adjustment necessary.
b. Defect in expansion valve.
c. Low on refrigerant.
d. Obstruction in system low pressure side circuit.

REFRIGERANT PRESSURE - TEMPERATURE RELATIONSHIP - For F-22

Temp. ^{o}F.	Gauge Pressure Psi	Temp. ^{o}F.	Gauge Pressure Psi
30	55	96	187
32	58	98	192
34	61	100	198
36	63	102	204
38	66	104	210
40	69	106	216
42	72	108	222
44	75	110	229
46	78	112	235
48	81	114	242
50	85	116	249
52	88	118	256
54	92	120	263
56	95	122	284
58	99	124	292
60	103	126	299
62	106	128	306
64	110	130	313
66	114	132	321
68	118	134	329
70	123	136	337
72	127	138	345
74	131	140	353
76	136	142	361
78	140	144	370
80	145	146	379
82	150	148	389
84	155	150	399
86	160	152	407
88	165	154	416
90	170	156	426
92	175	158	437
94	181	160	448

SERVICING THE EXPANSION VALVE (Fig. 16)

When necessary to clean, inspect, or replace parts, the power assembly and cage assembly may be removed without disconnecting any soldered joints.

1. Pump down the system as directed in "SYSTEM SERVICES AND TESTS," later in this group.

2. Disconnect the external equalizer line from power assembly. Pull remote bulb out of end of evaporator coil outlet manifold. Use care to prevent kinking or otherwise damaging capillary tubing.

3. Remove two cap screws attaching power assembly to body flange, remove power assembly, then lift out cage assembly.

4. When assembling valve, replace gaskets in proper places, and be sure the retaining pin on the valve cage enters the slot in the body flange.

5. Make sure the two lugs on the valve cage fit into grooves in the power assembly, and that the gear wheel on cage assembly meshes with adjusting gear in side of power assembly. Do not force the valve together - make the cage fit properly before tightening to the body flange.

CAUTION: If necessary to make soldered connections at body flange, first remove power assembly, cage assembly, and all gaskets. Keep heat away from all valve parts except the body flange.

6. Insert remote bulb into end of evaporator coil outlet manifold, making sure there are no sharp bends or kinks in the capillary tube.

EXPANSION VALVE FREEZES

Expansion valve trouble caused by moisture in system may be usually detected by an intermittent hissing sound at the expansion valve at high temperatures. Do not confuse this hissing sound with the hissing caused by a shortage of refrigerant. Excessive refrigerant causes a hissing sound ac-

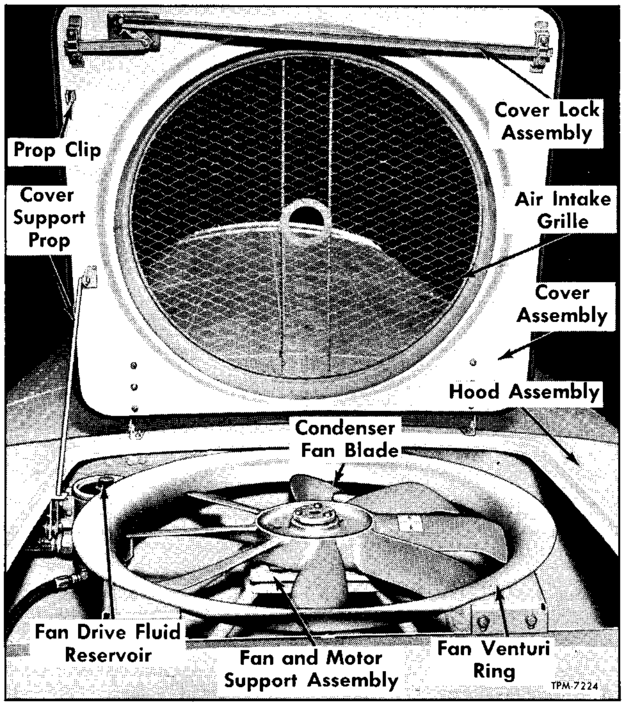


Figure 20—Access To Condenser Compartment

companied by a pounding vibration. When operating at low temperatures, moisture is indicated by the above, and by the fact that when the compressor is shut down and the valve warms up, it will become operative again for a short time.

If there is moisture in the system, it is necessary to evacuate the system with a vacuum pump, then replace the dehydrator-strainer. If moisture is still evident after one hour of operation, the dehydrator-strainer must be replaced again. Repeat until all moisture has been eliminated. Moisture trouble is caused by moist air entering piping when system is open, or from water in refrigerant container. Piping should be blown out with refrigerant before making final connections, particularly if piping has been open to air with high humidity content. After system has been pumped down and system opened, moisture is almost certain to be introduced. Always replace the dehydrator-strainer whenever the system has been opened and service again after a few hours of operation.

Many chemical preparations to be added to the refrigerant are now offered commercially for correcting moisture trouble. These preparations are anti-freeze solutions and are not suitable for use in compressor used in the system. The best practice is to always replace the dehydrator-strainer whenever the system has been opened. This absorbs the moisture rather than preventing it from freezing, and also eliminates the danger of corrosion of internal parts of system caused by the presence of moisture.

EVAPORATOR

Finned tube type evaporator is mounted in heating and cooling compartment under floor (fig. 17). If the underfloor air filter screens installed ahead of the evaporator are serviced frequently enough, there should be no maintenance required on the evaporator. However, if servicing the filters is neglected, some particles of dust, lint, etc., may pass through the filter; since the evaporator coils and fins are moist, these particles will cling to them. Dirt on the coils and fins acts as insulation and reduces the efficiency of the system, and when operating in humid climates, objectionable odors may develop caused by a mold-like formation or growth. In the event the evaporator does become dirty, it must be cleaned with air pressure and water and some cleaning agent which is not harmful to the aluminum tubes and fins. Since the location of the evaporator is not conducive to thorough cleaning in the vehicle, and considerable time is required for removing the evaporator for cleaning, the importance of cleaning or changing the air filters at frequent intervals should be impressed upon all maintenance personnel.

AIR FILTER SCREENS

AIR FILTER SCREENS, LOCATED IN THE UNDERFLOOR COOLING AND HEATING COMPARTMENT, MUST BE KEPT CLEAN FOR SATISFACTORY OPERATION OF THE AIR CONDITIONING SYSTEM.

Instructions for cleaning screens are explained under "HEATING AND VENTILATION" (SEC. 3).

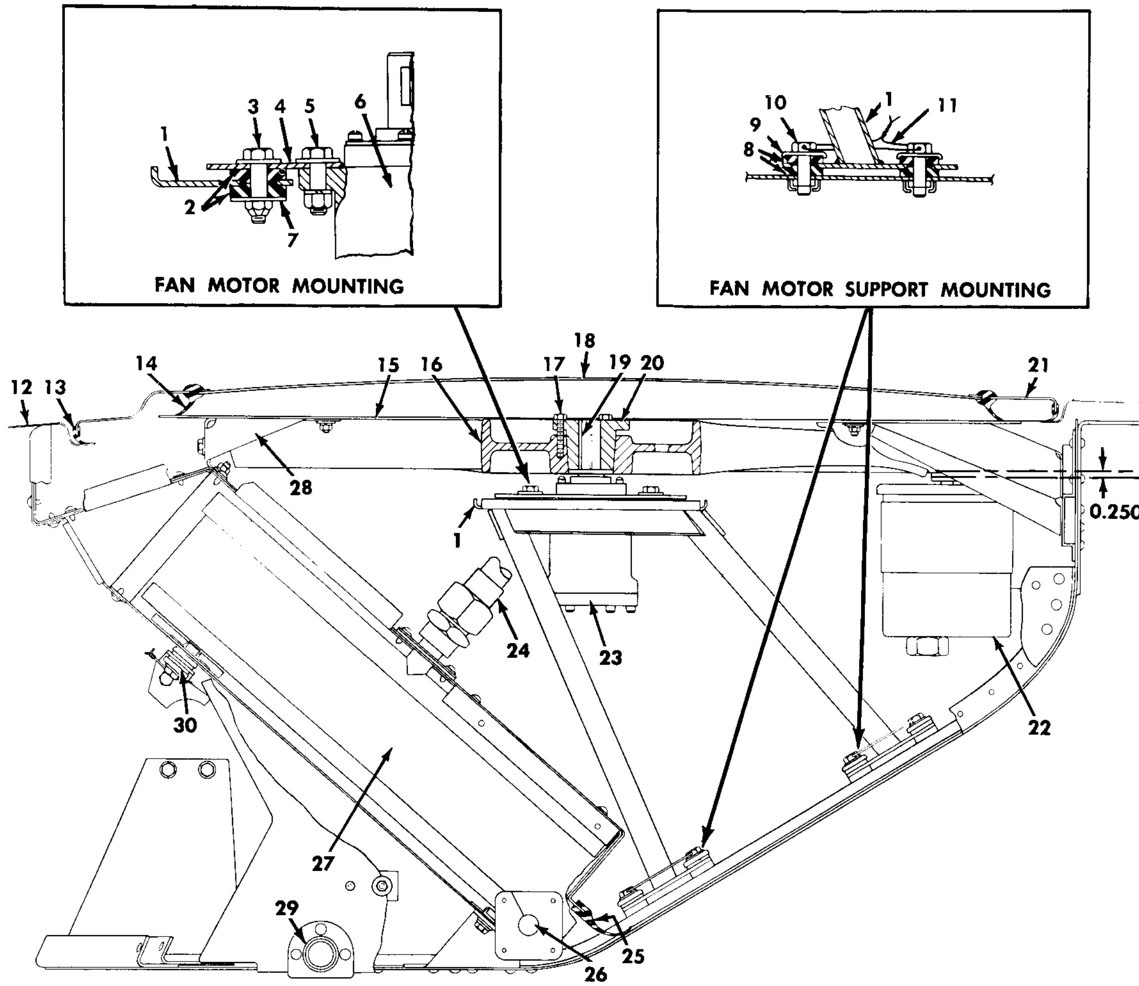
UNDERFLOOR BLOWERS AND MOTORS

Complete maintenance instructions on the underfloor blowers and motors are covered earlier under "HEATING AND VENTILATION" (SEC. 3) of this manual.

CONDENSER COMPARTMENT

Condenser compartment is located in roof at rear of coach and is covered by hood as shown in figure 20. Compartment contains the condenser coil, condenser cooling fan, fan motor, and motor drive hydraulic fluid reservoir. Figure 21 shows sectional view of compartment.

Compartment cover is equipped with an air intake grille. The compartment hood is equipped with an exhaust grille at rear. Both grilles are rubber insert retained in hood and cover opening. Hood cover is hinge-mounted to hood structure at front and is latched in closed position at rear.



1 Fan Motor Support Assembly
2 Rubber Mountings
3 Mounting Bolt
4 Mounting Plate
5 Mounting Bolt
6 Fan Motor Assembly
7 Flat Washer
8 Mounting Cushion
9 Mounting Cushion Retainer
10 Mounting Bolt
11 Lock Wire
12 Compartment Hood
13 Hood Cover Seal
14 Cover Air Intake Grille Seal
15 Venturi Ring
16 Fan Blade Assembly
17 Cap Screw
18 Air Intake Grille
19 Drive Key
20 Fan Blade Hub
21 Compartment Cover Assembly
22 Fluid Reservoir Assembly
23 Fan Drive Motor Assembly
24 Refrigerant Gas Line
25 Condenser Coil Lower Seal
26 Refrigerant Liquid Line
27 Condenser Coil Assembly
28 Venturi Ring Bracket
29 Compartment Drain
30 Coil Rubber Mounting

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Figure 21—Sectional View of Condenser Compartment

Hood cover hinge brackets can be adjusted to provide proper cover-to-hood opening fit. A square shank key is used to unlock hood cover (fig. 22). With hood closed, compartment is rubber sealed completely around perimeter to assure full air flow through condenser coil.

Cover and hood grilles must be kept clean at all times as leaves, bits of paper, or other obstructions will restrict air flow through condenser coil. Check and clean screens and grilles daily when operating air conditioning system.

Hood attached to coach structure with screws can be removed for purpose of replacing condenser coil after removing attaching screws around bottom of hood.

Moisture drain holes in rear corners of compartment must be kept clean and open.

Hood cover air intake grille opening should be kept covered during the off season. Instructions for covering openings are explained later under "SYSTEM SERVICES AND TESTS."

SYSTEM MAINTENANCE

CONDENSER

The condenser coil (27, fig. 21) is the medium through which the heat picked up by the refrigerant in the evaporator and the heat of compression is dissipated to the air. Since the heat in the gas must be dissipated through the walls of the coils and the fins, it is of extreme importance that the condenser be kept clean. THE IMPORTANCE OF KEEPING THE CONDENSER CLEAN CANNOT BE OVER-EMPHASIZED. When condenser becomes clogged or coated with dirt and road film, high head pressure occurs and extra operating power is required. Condenser must be cleaned at regular intervals.

Access to condenser is attained after raising hood cover which can be propped in raised position. Figure 20 shows view of the condenser compartment. Figure 21 shows sectional view of compartment.

Clean condenser coil as directed later under "SYSTEM SERVICES AND TESTS."

CONDENSER FAN AND DRIVE

CONDENSER FAN

Condenser fan is of eight-blade propeller type and is mounted above condenser coil in roof compartment at rear of coach (fig. 20). Fan pulls 9,000 cfm of air from above roof and pushes it through the condenser coil and discharges it out through expanded metal grille above rear window.

Fan is driven at constant speed (1800 rpm ±25 rpm) by a hydraulic motor which receives a constant flow of oil from a varying displacement pump. Pump is belt-driven from compressor flywheel.

Fan is adjustable vertically and the venturi ring around blades is also adjustable. Proper adjustment is obtained when lower edge of fan blade (16, fig. 21) extends 0.250" below edge of venturi ring (15, fig. 21).

FAN BLADE REPLACEMENT

NOTE: Key numbers in text refer to figure 21.

Removal

NOTE: Mark relationship of fan hub (20) and shaft of motor (23) to assure original positioning of parts when reinstalled.

1. Loosen three cap screws (17) which secure fan blade (16) to fan hub (20). Screws should be loosened to relieve clamping effect of fan hub on motor shaft.
2. Install same three screws in tapped holes of fan hub, then tighten screws evenly to separate fan from hub and to force hub from motor shaft. Remove hub and fan blade.

CAUTION: Handle fan blade carefully.

Installation

NOTE: Fan hub should be opened slightly (wedge and press) to permit installation over hub.

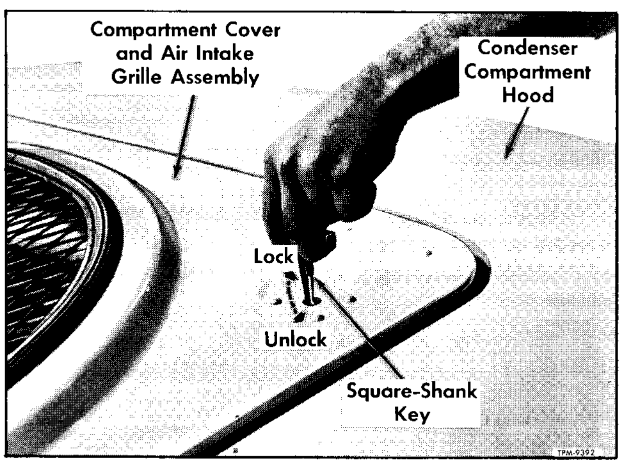


Figure 22—Unlocking Compartment Hood Cover

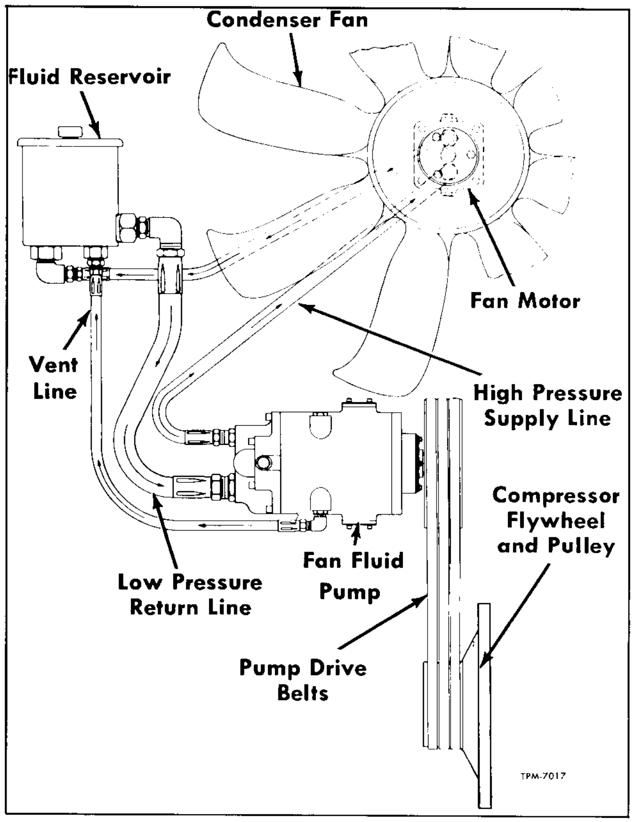


Figure 23—Schematic of Condenser Fan Drive Lines, and Units

1. Position fan blade (6) over taper of fan hub (20) and secure loosely with three attaching cap screws (17).

2. Locate drive key (19) into keyway of motor shaft, then slowly lower fan blade and hub down over motor shaft and into alignment with shaft key. Lower fan hub on shaft to marks made prior to fan removal, then tighten cap screws (17) alternately to 7-10 foot-pounds torque.

CONDENSER FAN DRIVE

Condenser fan drive units consists of a hydraulic motor, an oil reservoir, a hydraulic pump, and connecting lines. These units are shown schematically in figure 23. The pump hydraulically governs fluid flow to the fan motor to give a constant output speed. Fan motor is rubber mounted to motor support as shown in figure 21. Oil reservoir in same compartment is also rubber mounted (fig. 24).

Figure 25 shows a schematic of the condenser fan drive system. Figure 26 shows sectional view of fan pump and figure 27 shows sectional view of fan motor. Condenser drive pump is belt driven from compressor flywheel. Drive belts must be kept to tension specified later under "Belt Tension Adjustment."

Oil in reservoir must be kept to level specified later under "SYSTEM SERVICES AND TESTS."

A "Trouble Shooting Chart" on page 439 describes a malfunction or condition of system, the possible causes, and recommendations for making correction. Reference to this chart may supply information whereby it may not be necessary to remove, replace, or repair units.

DESCRIPTION AND OPERATION

The pump (fig. 26) is a rotating cylinder block type containing nine pistons in the block, whereby the block itself is keyed to the shaft by a spline. The pistons are spring-loaded to keep them constantly against the thrust plate, which is held in the casting of the swash plate. Swash plate is held so that a change in angle of piston stroke on the pistons in the cylinder block can be made. This angle is controlled by the power piston at the top of the pump which bears against the swash plate. It is by pressurizing with oil pressure or dumping the power piston area in accordance with input speed that a constant fluid flow is obtained at pump outlet. This assures constant speed of fan motor.

The actual starting of the fan pump is momentarily delayed (1 to 1-1/2 seconds) from the starting of the compressor, both of which are driven by the same clutch. This delay which is brought about by action of solenoid (7, fig. 7) mounted on fan pump, serves to reduce the initial clutch load and to eliminate rapid surge of hydraulic fluid to fan

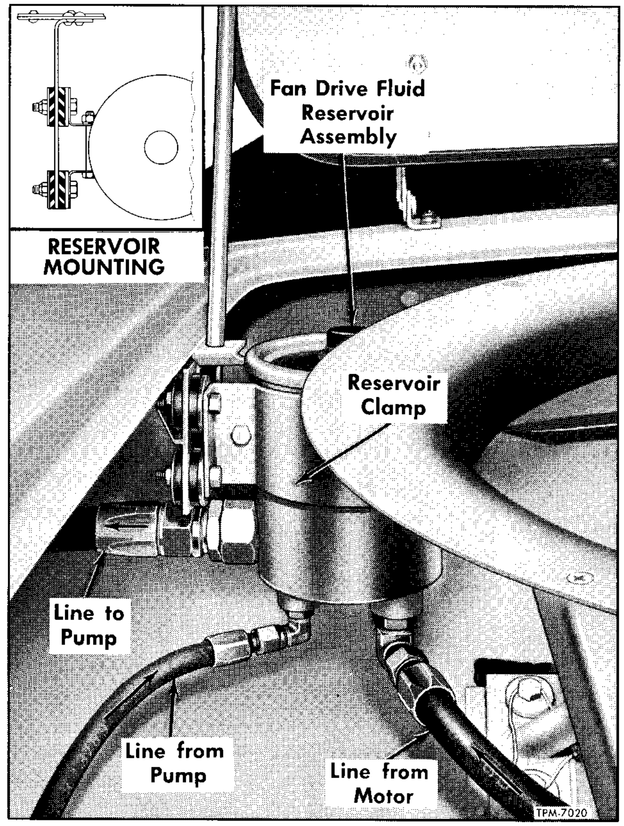


Figure 24—Fan Drive Fluid Reservoir Installed

motor when system starts to operate.

Refer to figure 25 which shows the solenoid location in the system fluid circuits.

When clutch engagement first occurs, pump solenoid is energized. Solenoid plunger is pulled from fluid passage seat to dump the high fluid pressure from pump power piston chamber into the pump low pressure circuit. When pressure is dumped the angle of pump swash plate is moved to the no-load or neutral position.

After a short delay, solenoid becomes de-energized and spring-loaded plunger within solenoid seats to close fluid passage through circuit. This permits build-up of fluid pressure to move pump swash plate to operating position.

Pump solenoid operation occurs as follows: When compressor clutch control air solenoid valve (26, fig. 7) releases air pressure to engage clutch, air pressure is also allowed to pass slowly through a 1/64" restriction fitting (27, fig. 7) from clutch control solenoid through line to air dome (29, fig. 7) on bulkhead. When the air pressure reaches 55 psi in this branch line the normally closed contacts of the pump air switch (28, fig. 7) in same line opens to break circuit to pump solenoid (7, fig. 7). Pump solenoid valve becomes de-energized to cause operation of fluid pump.

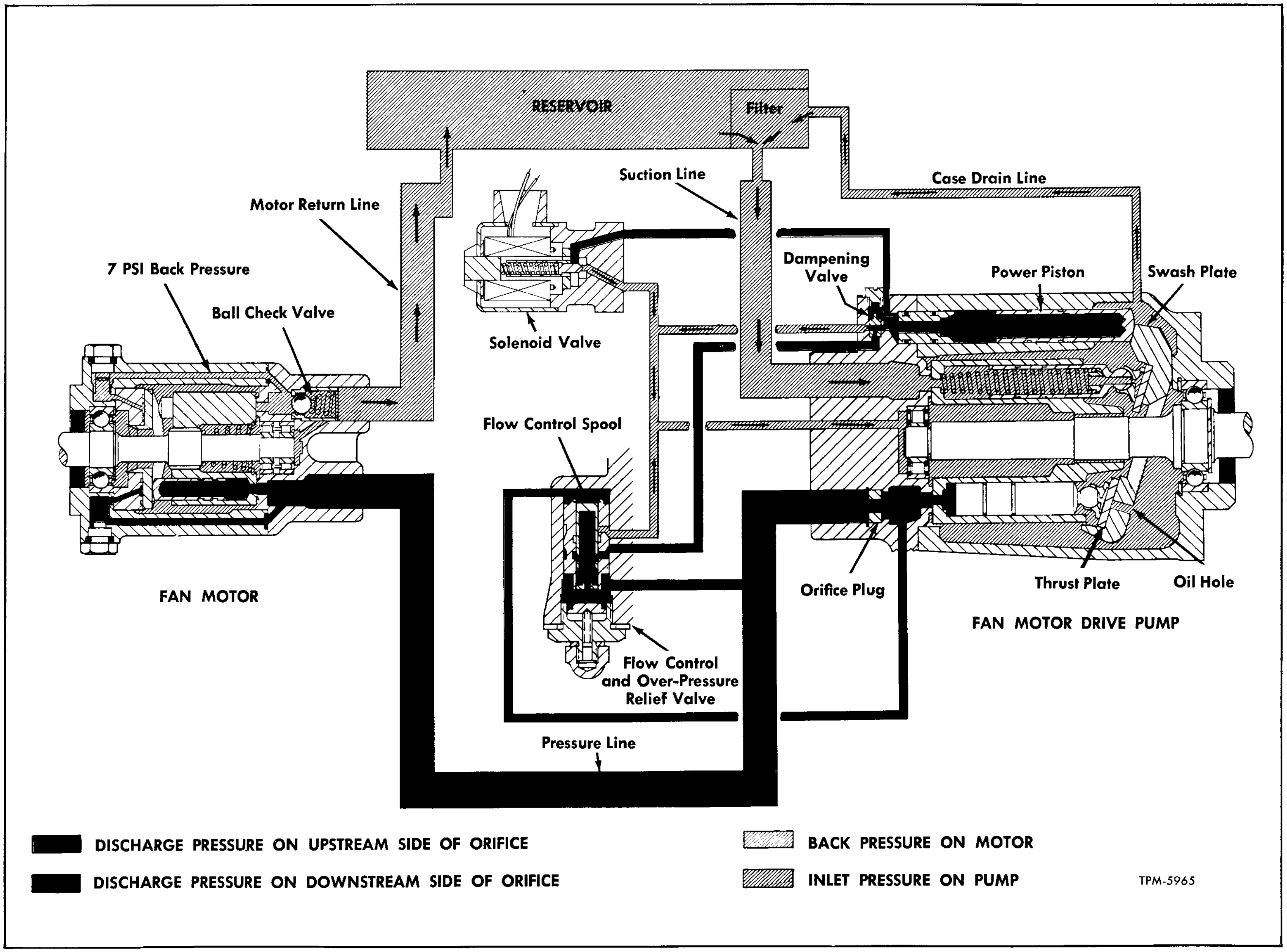


Figure 25—Schematic of Condenser Fan Hydraulic Drive System

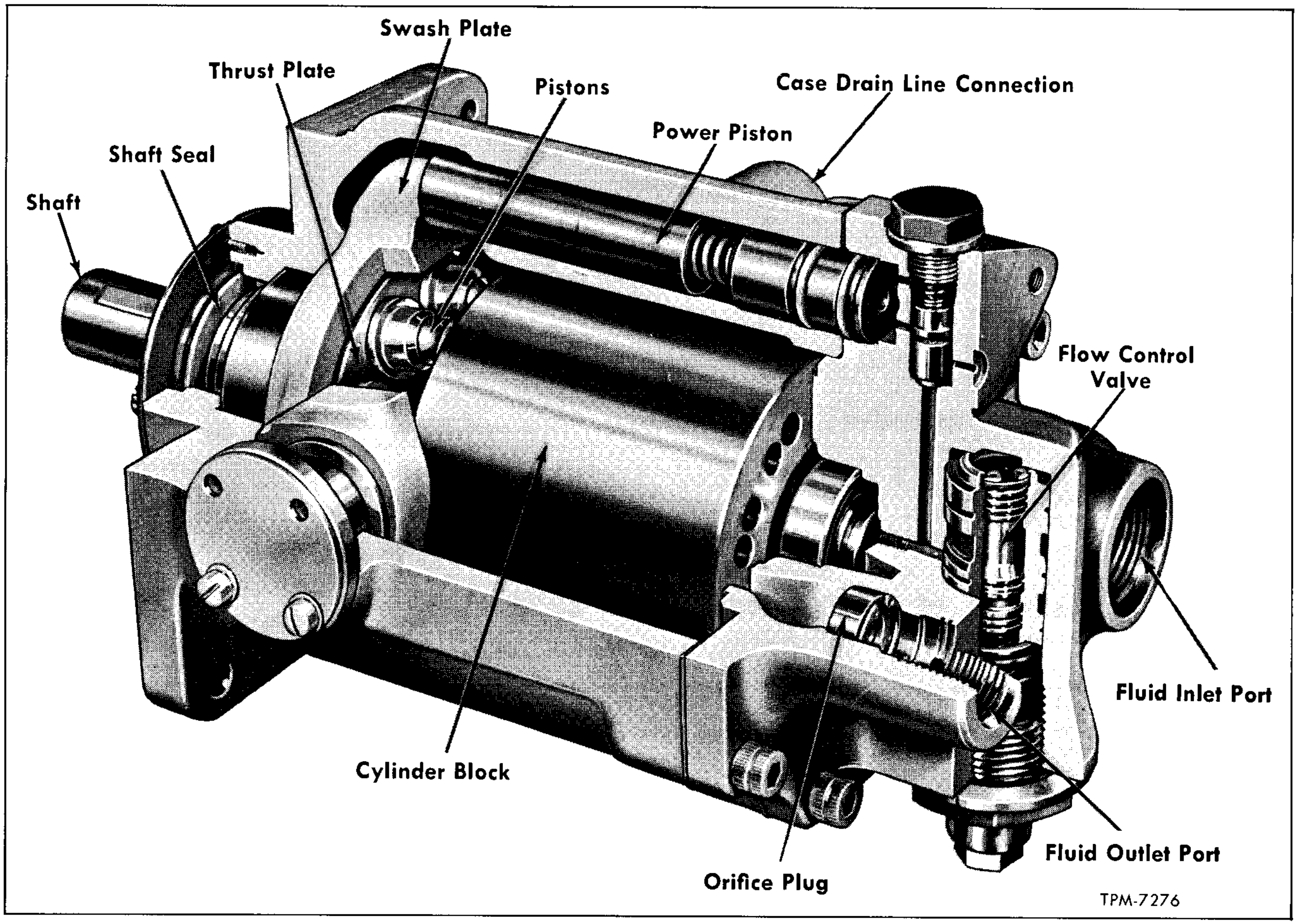


Figure 26—Cut-Away View of Condenser Fan Drive Pump

Pump Operation at Fast Idle or Above

NOTE: Refer to figure 24 which shows a schematic of the fan drive hydraulic system.

With compressor operating at fast idle or above, the pump components are positioned as shown. Since fast idle input speed on the pump will approximate 450 rpm, the greater angle of the swash plate increases stroke of pistons sufficiently to obtain 6 gallons per minute flow. As engine speed is increased with swash plate at this given angle a tendency to pump more than 6 gallons per minute flow occurs. As an attempt is being made to pass more than 6 gallons per minute through this 6 gallon orifice, a higher pressure on the upstream side of the orifice than on the downstream side of orifice occurs. This pressure buildup is reflected by internal coring to the top of flow control spool.

NOTE: The flow control spool is spring-loaded from the bottom.

Pressure build-up overcomes the spool spring and starts moving the flow control spool in a downward direction, closing the inlet line to the power piston chamber. As the spool moves downward, line to power piston is closed off and line to the pump case port is opened. Oil pressure is thereby relieved to the pump case and travels back to the reservoir through the case drain line. This dumps the power piston area, which allows the piston forces in the cylinder block to move the power piston back toward a shorter angle. Even through input speed on the pump has increased, the angle on the piston cylinder block is decreased, maintaining 6 gallon per minute flow.

Pump Operation When Decelerating

NOTE: Refer to figure 25 which shows a schematic of the fan drive hydraulic system.

When operating at a fast speed, a small angle exists on the pistons in the cylinder block. When decelerating, the rpm input at the cylinder block is slowed down and the pumping action is also slowed down, thus pump tends to pump less than 6 gallons per minute. Because of this, the pressure on upstream side of orifice decreases to approach the pressure in the downstream side of the orifice. Accordingly, the pressure across the flow control spool tend to approach each other as well. When

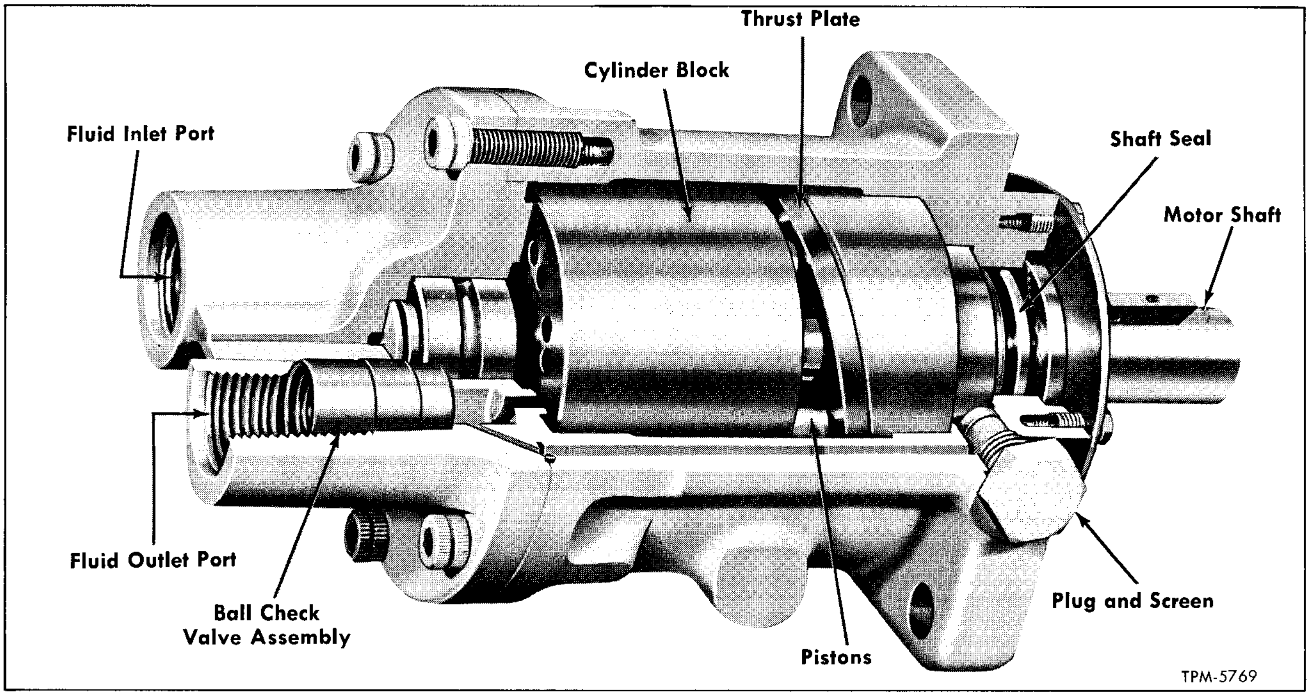


Figure 27—Cut-Away View of Condenser Fan Motor

this occurs, the spring at the bottom takes over and moves spool in an upward direction, opening the port into the power piston so that power piston becomes pressurized, forcing swash plate to a greater angle. Once again, pump provides 6 gallons per minute even though input speed has decreased when decelerating. The power piston pressure is pumped in accordance with input speed.

Fan Motor Operation (Refer to Fig. 25)

The fan motor is a constant displacement piston type motor containing nine pistons. The oil under pressure from the pump enters the motor and travels behind the motor pistons to force them up against the constant angle thrust plate. This forcing action of the pistons transmits a turning movement to the cylinder block, which is keyed to the motor shaft by a spline. The cylinder block then revolves and in turning drives the motor shaft and condenser fan.

The purpose of the ball check valve in the outlet port of the motor is to provide a back pressure which will prevent the pistons of motor from unloading as they cross over the valving from the pressure to discharge side. This action must occur since the pistons are not spring-loaded, and if check valve were not present, a piston clatter would develop and pistons would tend to wear on piston heads.

Both the pump and motor are hydrostatically balanced. The pump accomplishes this by the hollow pistons which transmits oil up to the slipper heads which are bearing against the face of the thrust plate. In the motor, same effect is accomplished by cored lines. Thus whatever pressure is in a given piston at any time is also placed behind the piston head and thrust plate so that the piston is hydrostatically balanced.

FAN DRIVE MAINTENANCE

CONDENSER FAN HYDRAULIC DRIVE FLUID

The condenser fan hydraulic fluid level should be checked at regular coach lubrication intervals. Fluid level check is made at the system fluid reservoir which is mounted in the condenser compartment on coach roof. Fluid level should be to "OIL LEVEL" mark on reservoir screen. If necessary, add fluid.

IMPORTANT: DO NOT OVERFILL.

Filter element in reservoir should be changed at beginning of operation season. Instructions for replacing element are explained later in this section under "Condenser Fan Fluid Reservoir."

Instructions for changing system fluid is explained later under "SYSTEM SERVICES AND TESTS."

At regular intervals all hydraulic lines and line connections should be checked for leakage. Inspect lines for possible chafing at supports to coach body. If this condition is found, lines should be repositioned and insulated. NOTE: Well insulated lines will reduce system noise.

FAN VENTURI RING ALIGNMENT

Fan venturi ring (15, fig. 21) should be located concentric with fan blade and should be positioned in relation to end of fan blade to height shown in figure 21. Height adjustment is made at mounting brackets which support venturi ring. Adjust bracket position by loosening screws which attach brackets to supports. Raise or lower venturi ring to dimension shown. Make sure specified dimension is obtained at all brackets. Tighten bracket attaching screws firmly after making adjustment.

PUMP DRIVE BELTS

Drive belts must be kept at proper tension. A loose or broken belt will affect pump operation. Belts adjusted too tight will strain and cause rapid wear of bearings in pump assembly. A regular periodic inspection is recommended to check condition and tension of drive belts (figs. 28 and 29). Replace if frayed or worn.

IMPORTANT: When replacing triple V-type belts, it is essential that entire set be replaced at same time. Belts are available in matched sets only. Belts can be replaced as explained later under "SYSTEM SERVICES AND TESTS."

NOTE: On a new vehicle or after having installed new belts, check tension of belts twice in first 48 hours of system operation.

PUMP DRIVE BELT TENSION ADJUSTMENT

Pump is pivot-mounted on one attaching bolt at uppermost mounting, and belt tension adjustment is accomplished by means of slotted holes in pump bracket at remaining three attaching bolts (View A, fig. 28). A 1/4 to 3/8 inch deflection, midway between pulleys on belts (View A, fig. 28) is satisfactory.

To make adjustment, loosen nuts of all four pump attaching bolts. View B, figure 28 shows the wrench arrangement which will readily facilitate reaching the pump rear mounting bolt. Using a small pry bar as shown (View C, fig. 28), force pump outward to increase tension on belts. Tighten all four attaching bolt nuts firmly after proper tension is obtained.

PUMP DRIVE BELT ALIGNMENT

At regular intervals pump drive belt alignment should be checked as misalignment could cause rapid wear on belts. Figure 29 shows pump mounted and belts properly aligned. Proper alignment exists when pump pulley belt grooves are squared with belt grooves on compressor flywheel pulley within clutch housing. This alignment can be made by moving pulley and tapered hub in or out on pump motor shaft. Pulley and hub are retained to shaft with three screws. Move pulley and hub on shaft as necessary, then retighten screw to 80 inch-pounds. Also, proper alignment exists when pulley

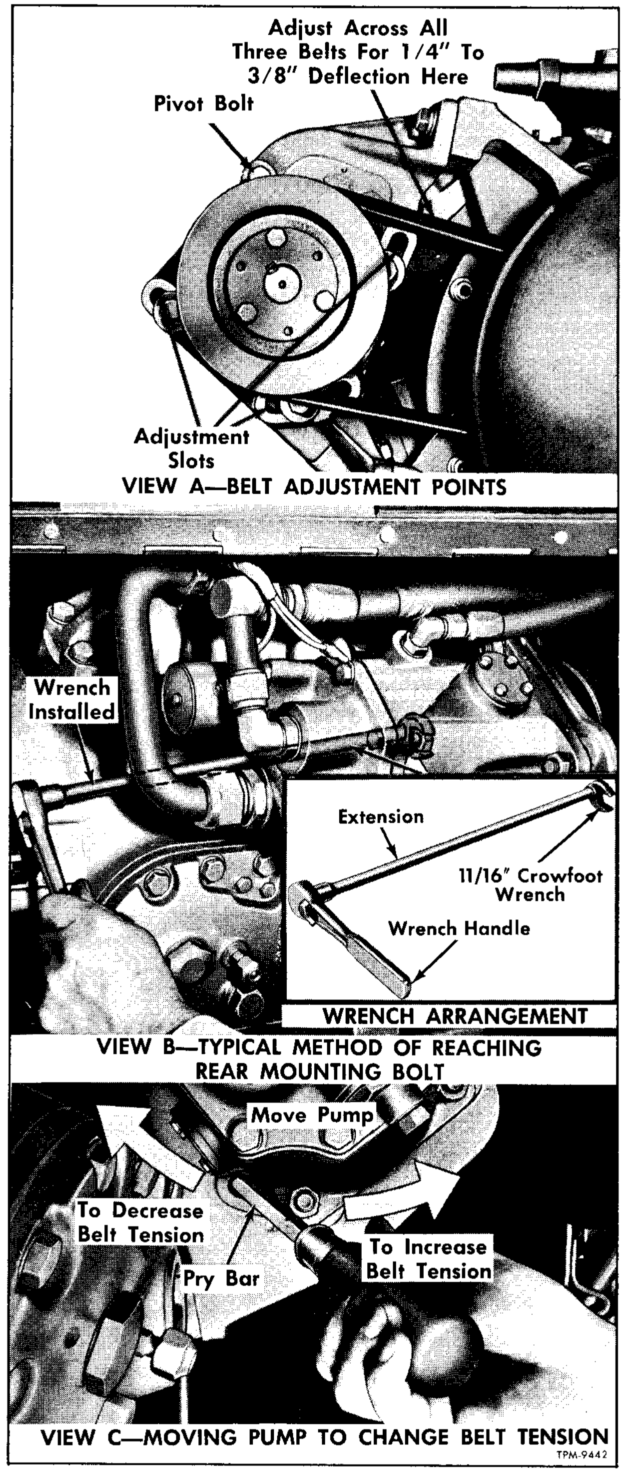


Figure 28—Adjusting Fan Drive Pump Belt Tension

grooves are on same plane. Misalignment here could occur if the four bolts which attach pump mounting bracket to the clutch housing should loosen. Bolt holes in mounting bracket are larger than bolt diameters to allow adjustment (fig. 29) and

SYSTEM MAINTENANCE

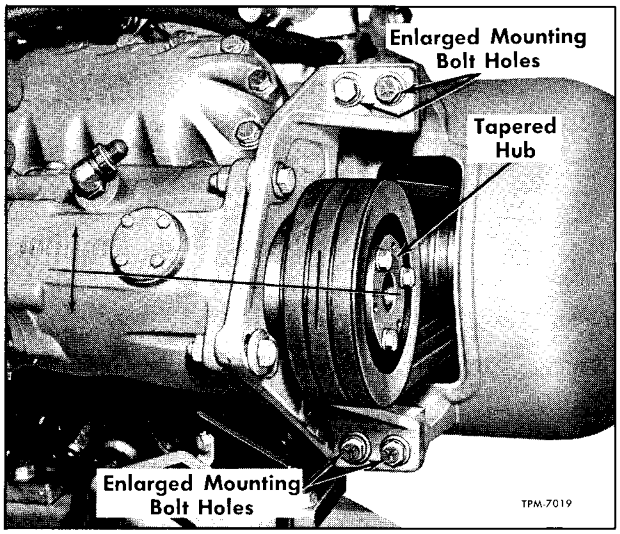
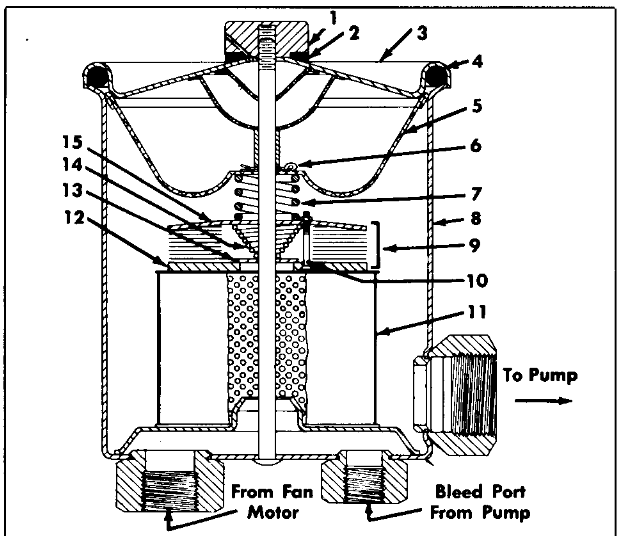


Figure 29—Pump and Drive Belt Alignment Points

loosened bolts could allow entire pump and bracket unit to shift on clutch housing. Raise or lower line end of pump as necessary, then tighten all four bracket-to-clutch housing bolts firmly.

FAN SPEED ADJUSTMENT

Refer to "SYSTEM SERVICES AND TESTS" later in this group for adjustment procedures. See "Condenser Fan Speed Check and Adjustment."



1 Nut
2 Nut Gasket
3 Reservoir Cover Assy.
4 Cover O-ring Seal
5 Strainer Screen
6 Cotter Pin
7 Spring
8 Reservoir Housing
9 By-pass Filter Assy.
10 Filter Screw
11 Filter Element
12 By-pass Filter Plate
13 By-pass Valve Disc
14 Valve Disc Spring
15 By-pass Filter Cover

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Figure 30—Sectional View of Fluid Reservoir

CONDENSER FAN FLUID RESERVOIR

Fluid reservoir is used in the fan hydraulic drive system to retain sufficient supply of fluid in system and to filter the fluid. Reservoir is rubber-mounted and is located in the condenser compartment (fig. 24). A disposable type filter element is located in bottom of reservoir (fig. 30) with a fluid by-pass filter and valve located directly on top of element. Purpose of the by-pass valve is to allow passage of fluid through reservoir in the event the filter element becomes clogged.

The system fluid and the disposable type element should be replaced annually, preferably at beginning of the operating season.

DISASSEMBLY

NOTE: Key numbers in following text refer to figure 30.

1. Remove nut (1) with gasket (2) then lift cover (3) from reservoir housing (8). If necessary, remove cover O-ring seal (4) from cover.
2. Using thin-nose pliers as shown in figure 31, remove small cotter pin (6) which retains strainer screen (5) in housing. CAUTION: Do not poke hole in screen with pliers when cotter pin releases from thru bolt. Lift screen from housing.
3. Remove spring (7), by-pass filter assembly (9) and filter element (11) from reservoir housing. Discard element.
4. Disassemble by-pass filter assembly (9) by removing three filter screws (10) and nuts. Disassemble filter assembly completely.

CLEANING

Clean all removed components in cleaning solvent and allow to dry thoroughly. Using a clean lint-free cloth, swab out reservoir housing.

ASSEMBLY

NOTE: Key numbers in following text refer to figure 30.

1. Referring to figure 30 for positioning of parts, assemble by-pass filter assembly (9). Tighten filter attaching screw nuts evenly.
2. Place new filter element (11) into reservoir housing (8), then place by-pass filter assembly (9) on top of element.

IMPORTANT: Make sure filter assembly is positioned as shown. Screw nuts should be located at top side of filter.

3. Locate spring (7) over reservoir thru bolt, then install strainer screen (5). Secure screen with cotter pin (6). NOTE: Carefully press screen down in center to permit the installation of cotter pin.
4. Place O-ring seal (4) in groove of cover (3), then position cover on housing.
5. Before installing cover nut (1) and nut gas-

ket (2), prod small diameter wire into vent holes in cover (3) and cover nut (1). See figure 32 which shows nut removed and vent holes exposed.

6. With gasket (2) located in groove of cover nut (1), install nut.

NOTE

Hand tighten nut, do not use wrench.

FAN MOTOR AND SUPPORT REPLACEMENT

NOTE: Key numbers in text refer to figure 21.

REMOVAL

1. Remove condenser fan blade from motor shaft as explained previously under "Fan Blade Replacement."

2. Drain hydraulic fluid from system to level slightly below fan motor line connections. Break high and low pressure line connection at pump and allow fluid to drain into a clean container.

3. Mark fluid lines at fan motor ports, then disconnect lines. Cap ends of lines to prevent dirt from entering.

4. While supporting motor, remove four bolts (5) which attach fan motor to motor mounting plate (4), then lower motor from motor support (1).

5. If it is necessary to remove fan motor support (1), refer to right upper view of figure 21, which shows construction of support at coach roof mounting. Remove lock wire and attaching bolts, then remove fan venturi ring (15) attached to brackets. Lift support from compartment.

INSTALLATION

1. Lower fan motor support (1) into position at coach roof, then referring to upper right view of figure 21, install mounting components under each leg of motor support. Secure heads of all bolts with lock wire (11).

2. Raise fan motor into position under motor support and attach with four bolts (5) inserted from top. See upper left view of figure 21.

NOTE

Make sure motor is positioned with port marked "OUT" toward front of compartment. Tighten attaching bolts firmly. Install fluid lines.

3. Install fan blade assembly as instructed previously under "Fan Blade Replacement."

4. Lower fan venturi ring (15) to condenser mounting brackets and install attaching bolts loosely. Locate venturi ring concentric with fan blade as instructed previously under "Fan Venturi Ring Alignment."

5. Refill fan drive fluid system as instructed later under "SYSTEM SERVICES AND TESTS."

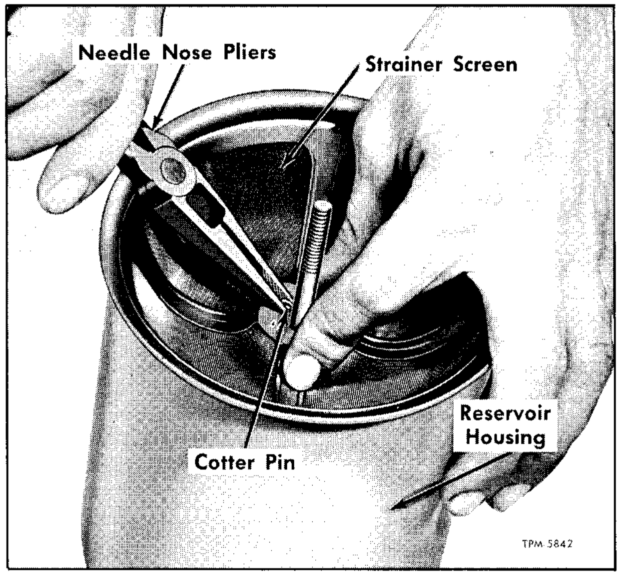


Figure 31—Method of Replacing Fluid Reservoir Screen and Cotter Pin

FAN DRIVE PUMP REPLACEMENT

REMOVAL

1. Drain condenser fan fluid system by disconnecting all three fluid lines at pump. Drain fluid into clean container, then cover container. Cap ends of lines and holes in pump to prevent dirt from entering system.

2. Remove drive belts from pump pulley. Instructions explained previously under "Pump Drive Belt Tension Adjustment" will apply.

3. Mark upper and lower end of pump mounting bracket in relation to flange on clutch housing.

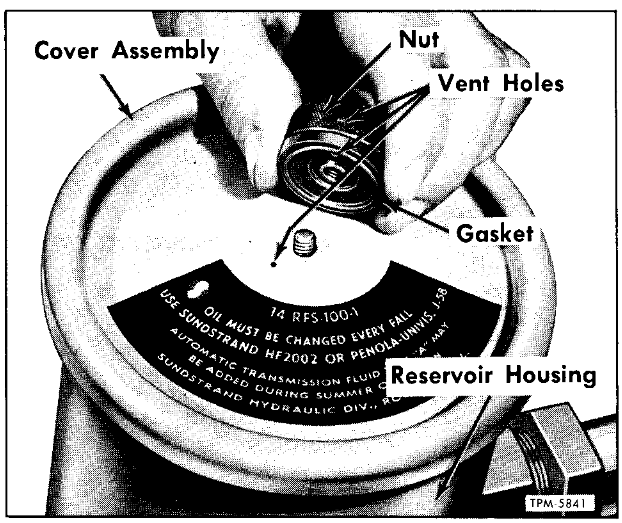


Figure 32—Vent Hole Locations In Reservoir Cover and Nut

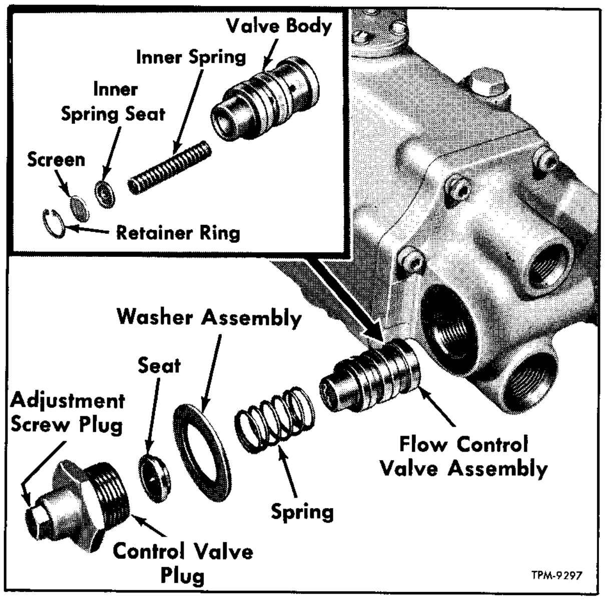


Figure 33—Pump Flow Control Valve Components

This will assure installation of pump in original position.

4. While supporting pump, remove four bolts which attach pump bracket to clutch housing. Remove pump with mounting bracket and pulley.

5. Pulley and hub are attached to pump shaft with three screws. Mark pulley position (distance of pulley on shaft) in relation on shaft, then using hub screws as puller screws, remove hub and pulley.

6. Remove pump bracket after removing four attaching bolts and nuts.

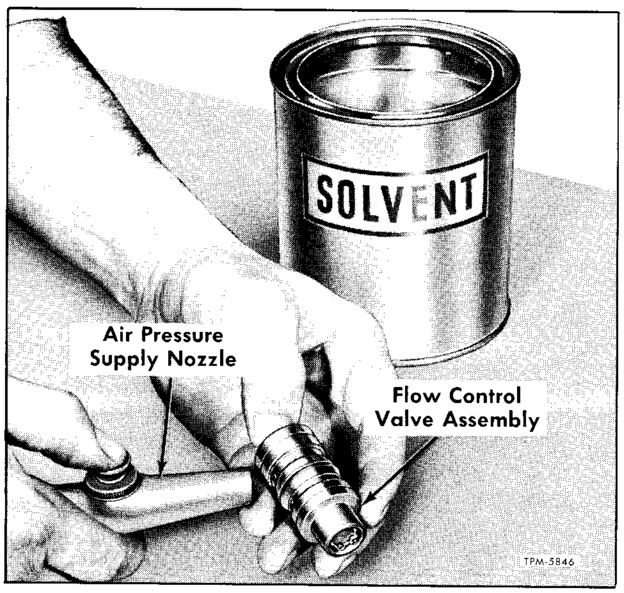


Figure 34—Cleaning Flow Control Valve Using Air Pressure

INSTALLATION

1. Position pump bracket over pump shaft and attach to pump flange loosely with four bolts and nuts. Install pulley and hub with drive keys to mark made prior to removal on shaft. Tighten three hub screws evenly to 7-10 foot-pounds torque.

NOTE: Pump pulley should be located on pump shaft to align exactly with compressor flywheel pulley.

2. Mount pump and mounting bracket to clutch housing flange with four bolts. Align marks on upper and lower flanges made prior to removal, then tighten bolts firmly.

3. Install drive belts in respective pulley grooves. Tighten belts to proper tension as instructed previously under "Pump Drive Belt Tension Adjustment."

4. Connect fluid lines to pump ports. Tighten connections firmly.

5. Fill fluid system and bleed as instructed later under "SYSTEM SERVICES AND TESTS."

SERVICING FAN DRIVE PUMP FLOW CONTROL VALVE

NOTE: Usually one of the first indications of system malfunction is erratic operation of the condenser fan motor or of motor operating at a slower speed than specified. Placing of a tachometer on the fan motor will indicate the motor speed, which should be 1800 $\pm$ 25 rpm. Speed check should be made with engine at fast idle (460 rpm - min.) and with fan motor fluid at normal operating temperature. Instructions for checking fan speed are explained later under "SYSTEM SERVICES AND TESTS."

Possible cause of erratic fan motor operation could be a sticking flow control valve.

1. Drain hydraulic fluid from system. Disconnect lines at pump and allow to drain.

2. Remove flow control valve plug which is the large hex plug having a small adjustment screw cover plug at the end. See figure 33. DO NOT REMOVE SMALL END PLUG.

IMPORTANT: Do not allow parts to drop out of pump cavity, as lands of valve could be damaged by contacting other parts.

3. Referring to figure 33, remove seat, washer assembly, valve outer spring and valve assembly from pump. Use extreme care not to damage valve.

4. Being careful not to damage small screen in small end of valve body, remove retainer ring, screen, inner spring seat, and the inner spring from valve body. NOTE: Do not remove expansion plug at opposite end of valve body. Valve plunger within valve body should not be removed.

5. Dip valve body into cleaner solvent, then wearing safety glasses, blow solvent and foreign matter from valve. Use air pressure as shown in

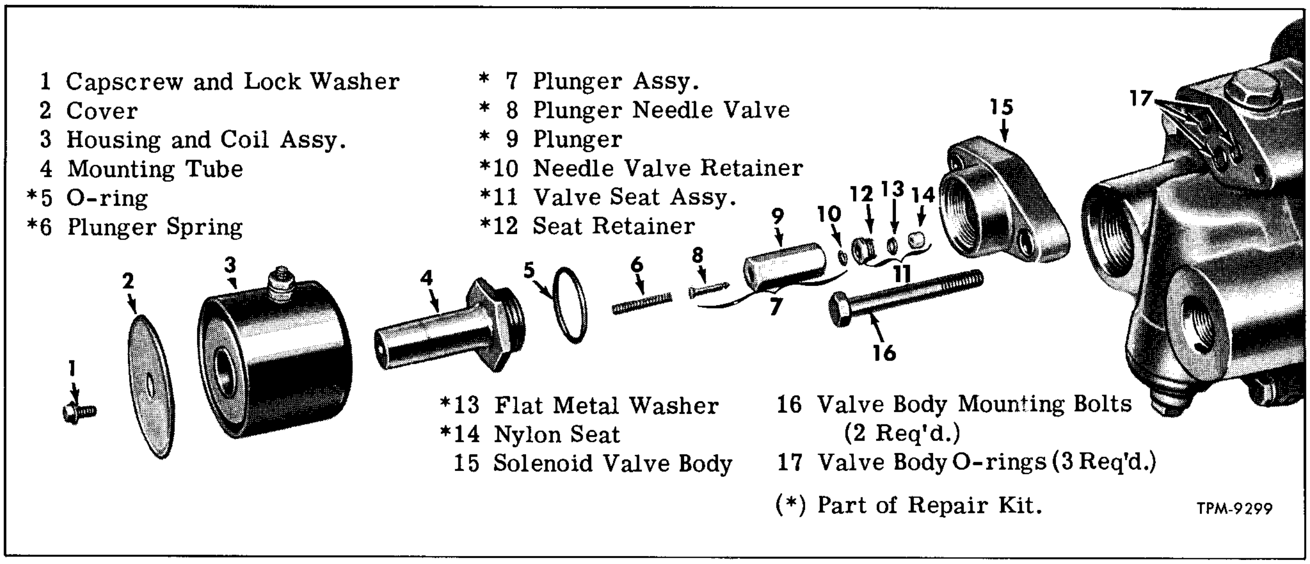


Figure 35—Pump Solenoid Valve Components

figure 34 directing air stream into valve side ports. Dip all other valve components in solvent, then wipe and blow dry. Inspect valve body for worn or scored condition. If body is badly scored, the complete end cap assembly should be replaced.

NOTE: Before installing new end cap assembly the piston block within the pump should be lapped. See lapping procedure under overhaul procedures explained later under "Fan Drive Pump Overhaul."

6. Reinstall inner spring, spring seat, screen and retainer ring in valve body.

7. Carefully insert flow-control valve assembly into pump. NOTE: Do not attempt to force valve into valve bore. Also make sure proper end of valve is inserted first; refer to figure 33 for position of parts. If valve temperature is higher than temperature of pump it may be impossible to install valve. Wait until temperature of both parts equalize.

8. Referring to lower view of figure 33, install spring, washer assembly, spring seat, and control valve plug assembly. Tighten plug firmly.

9. Fill system with fluid, then operate the system until system fluid is hot; check fan motor operation.

10. If necessary, the fan speed can be adjusted as explained later under "SYSTEM SERVICES AND TESTS."

PUMP SOLENOID VALVE REPLACEMENT AND REPAIR

NOTE: A defective solenoid valve or a solenoid valve having a loose valve seat or an obstruction at seat may cause pump to stop producing pressure. Repair solenoid valve as follows:

REMOVAL

NOTE: Key numbers in text refer to figure 35.

1. Drain fluid from system. Disconnect lines at pump and allow to drain.

2. Disconnect wire from solenoid terminal.

3. Referring to figure 35, remove cap screw (1) and cover (2) from solenoid housing (3). Slide housing from mounting tube (4).

4. Remove mounting tube from valve body (15), then remove spring (6) and plunger assembly (7) from tube. Also remove the O-ring (5) from threads of tube. NOTE: The plunger assembly can be disassembled after removing needle valve retainer.

5. Using wrench, remove valve seat assembly (11) from valve body.

6. If necessary to remove valve body, remove two attaching bolts, then separate body from pump. Remove three O-rings (17) from recesses in pump flange.

INSPECTION AND REPAIR

NOTE: Key numbers in text refer to figure 35. All items identified by an asterisk (*) in figure 35 are part of valve seat plunger kit.

IMPORTANT

DO NOT ATTEMPT TO USE OLD PARTS WITH NEW PARTS. INSTALL ALL PARTS OF NEW KIT.

1. Check bore of mounting tube (4) for dirt. Clean, using a solvent and blow dry with air pressure.

2. Visually check coil within housing (3) for broken wiring and for cracked insulation. Circuit through coil can be checked using a 12-volt power source and a low candle-power test light.

3. Clean out fluid passages in valve body (12).

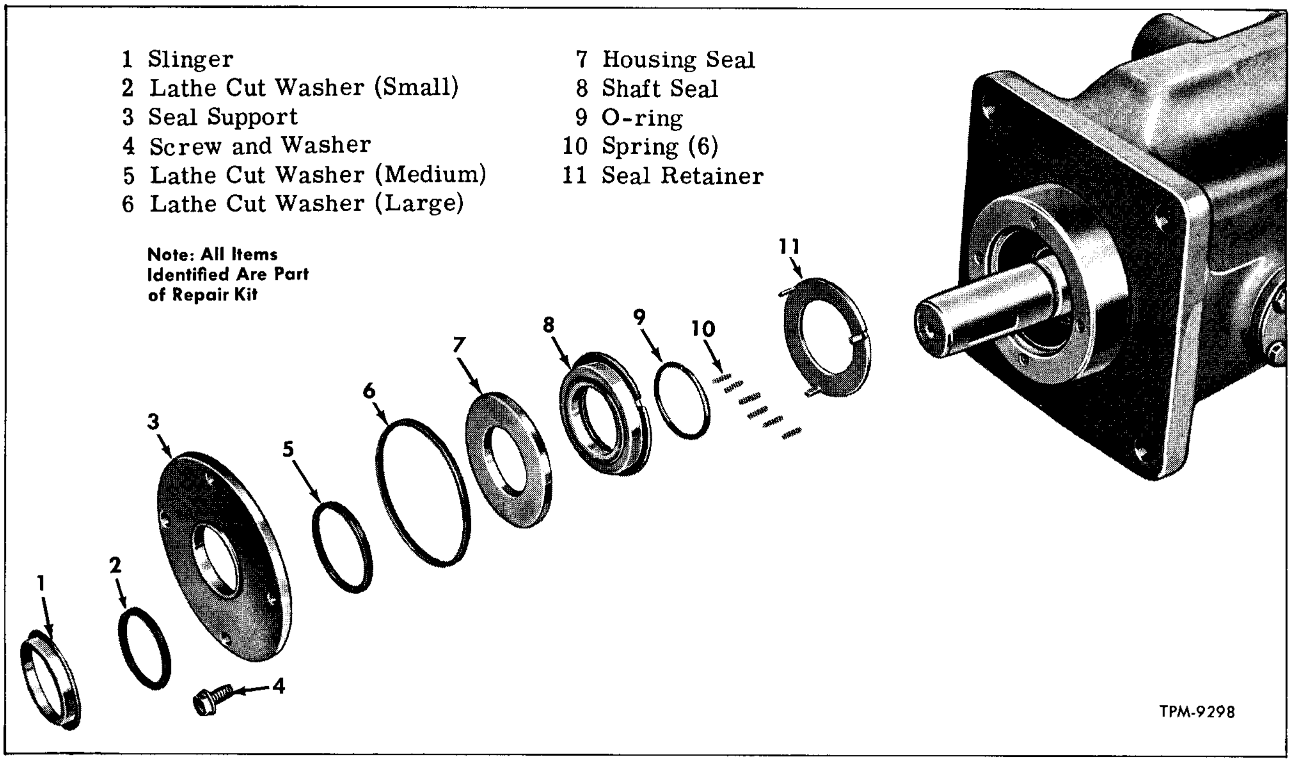


Figure 36—Pump Shaft Seal Components

ASSEMBLY

NOTE: Key numbers in text refer to figure 35.

1. Install three O-rings (17) in pump flange recesses, then attach valve body (15) to pump flange with two bolts (16). NOTE: Make sure passages in body and pump are aligned. Tighten bolts evenly and firmly.

2. Insert small flat metal washer (13) in seat retainer (12), then position nylon seat (14) against washer making up valve seat assembly (11). Thread assembly finger tight, then using wrench tighten an additional quarter turn.

IMPORTANT: NYLON SEAT (14) WILL BE DESTROYED IF TIGHTENED MORE THAN ONE QUARTER TURN.

3. If plunger assembly (7) was disassembled, position needle valve (8) into plunger (9), then clamp retainer (10) into groove at pointed end of valve.

4. Place O-ring (5) over threads of mounting tube (4), then with spring (6) located in plunger, insert plunger assembly into tube and thread tube assembly to valve body. Tighten mounting tube firmly.

5. Slide housing and coil assembly (3) over end of tube, then with housing terminal located for easy attachment of wire, install cover (2) with capscrew and lock washer (1). Tighten screw firmly.

6. Connect wiring to terminal, fill fluid system, then check pump and solenoid operation.

PUMP SHAFT SEAL REPLACEMENT

NOTE: It is necessary to drain fluid from system and then remove pump assembly from coach before replacing pump shaft seal.

All items identified by an asterisk (*) in figure 36 are components of shaft seal service kit.

NOTE: INSTALL ALL PARTS OF SERVICE KIT. DO NOT MIX OLD PARTS WITH NEW PARTS.

REMOVAL

Key numbers in text refer to figure 36.

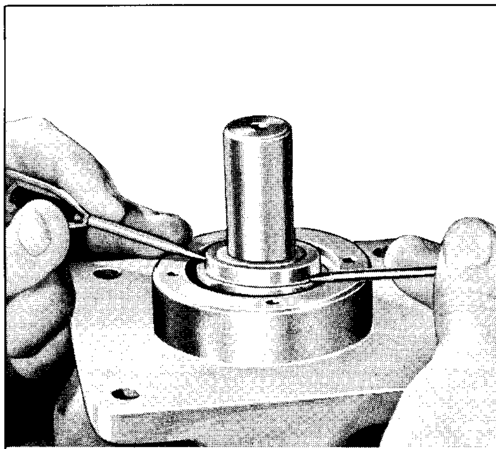
1. Remove drive key from end of pump shaft.

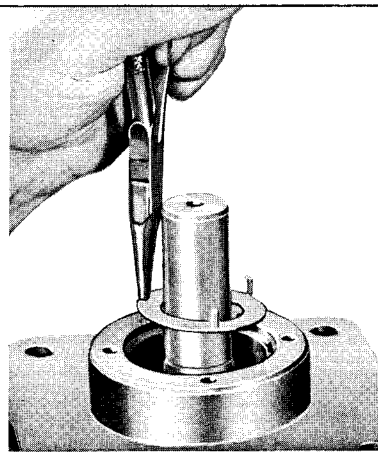
2. Slide small metal slinger (1) and small lathe cut washer (2) from pump shaft. Separate washer from slinger.

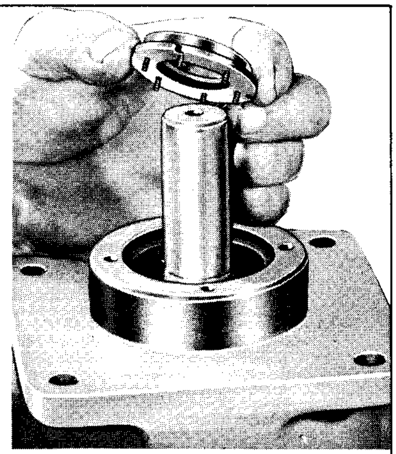
3. Remove four screws (4) and washers which attach seal support (3) to pump housing. Lift support from housing, then remove lathe cut washers (5 and 6) from underside of support.

4. Remove housing seal (7) and pump shaft seal (8) using flats of two small screwdrivers as shown in left view of figure 37. Be careful not to lose six small springs (1) in shaft seal. Remove O-ring (9) from internal groove of shaft seal (8).

5. Grasp pump shaft seal retainer (11) by one of its prongs with needle nose pliers and lift out as shown in center view of figure 37.


REMOVING PUMP SHAFT SEAL


REMOVING SEAL RETAINER


INSTALLING PUMP SHAFT SEAL AND SPRINGS

TPM-5981

Figure 37—Pump Shaft Seal Replacement Views

INSTALLATION

NOTE: Pump shaft seal components are serviced in a kit only. DO NOT USE OLD PARTS.

IMPORTANT: APPLY CLEAN HYDRAULIC FLUID TO ALL COMPONENTS OF SEAL KIT PRIOR TO INSTALLING.

1. Examine and clean recess in pump housing.
2. Lower seal retainer (2) over shaft and rotate until retainer flats seat or align with flats on pump shaft.
3. Install O-ring (9) into internal groove of pump shaft seal (8). Fill six spring cavities in shaft seal (8) with clean grease to retain springs (10). Place springs in seal cavities. Referring to right view of figure 37, install seal with springs over shaft end and match three slots on seal collar with three prongs of seal retainer (11).
4. Making sure clean film of fluid covers seal contact surfaces, place pump housing seal (7) over shaft to shaft seal.
5. Install lathe cut washer (6) into groove between outer circumference of housing seal and pump housing seal opening. IMPORTANT: DO NOT STRETCH WASHER. Use of shim stock will facilitate installing of washer.
6. Position lathe cut washer (5) into groove at back side of seal support (3), then position seal support over shaft to housing. Make sure housing seal (7) and washers (5 and 6) remain in position. Install seal support attaching screws with washers (4) loosely.
7. Insert small lathe cut washer (2) into pump slinger (1), then locate slinger with washer over end of shaft and up against seal support (3). Making sure slinger washer is contacting support, final tighten the four seal support attaching screws.
8. Install pump assembly as directed previously.
9. Operate system until normal operating temperature of oil is reached (5 to 10 min.), then check for leakage at seal.

MOTOR SHAFT SEAL REPLACEMENT

NOTE: Motor shaft seal components can be replaced without having to remove motor from coach.

IMPORTANT: All items identified by an asterisk (*) in figure 38 are components of motor shaft seal service kit. INSTALL ALL PARTS OF SERVICE KIT. DO NOT MIX OLD PARTS WITH NEW PARTS.

REMOVAL

NOTE: Key numbers in text refer to figure 38.

1. Remove fan from motor as directed previously under "Fan Blade Replacement."
2. Remove fan drive key from end of motor shaft.
3. Slide small metal slinger (13) and lathe cut washer (12) from motor shaft.
4. Remove four screws (14) with washers (15) which attach seal support (11) to motor. Lift seal support from motor, then remove lathe cut washers (10 and 9).
5. Referring to figure 39, press downward around outer surface of housing seal (8) and shaft seal (7). Seals should pop up out of motor recess. Left view of figure 37 shows method of removing seals using flats of two small screwdrivers.
6. Remove O-ring (6) from internal groove of shaft seal (7).
7. Remove seal spring (5) from housing recess.
8. Using No. 2 Tru-Arc snap ring pliers, remove retaining ring (4) and remove thrust washer (3) from motor shaft. Using needle-nose pliers, lift spring retainer (2) from shaft.

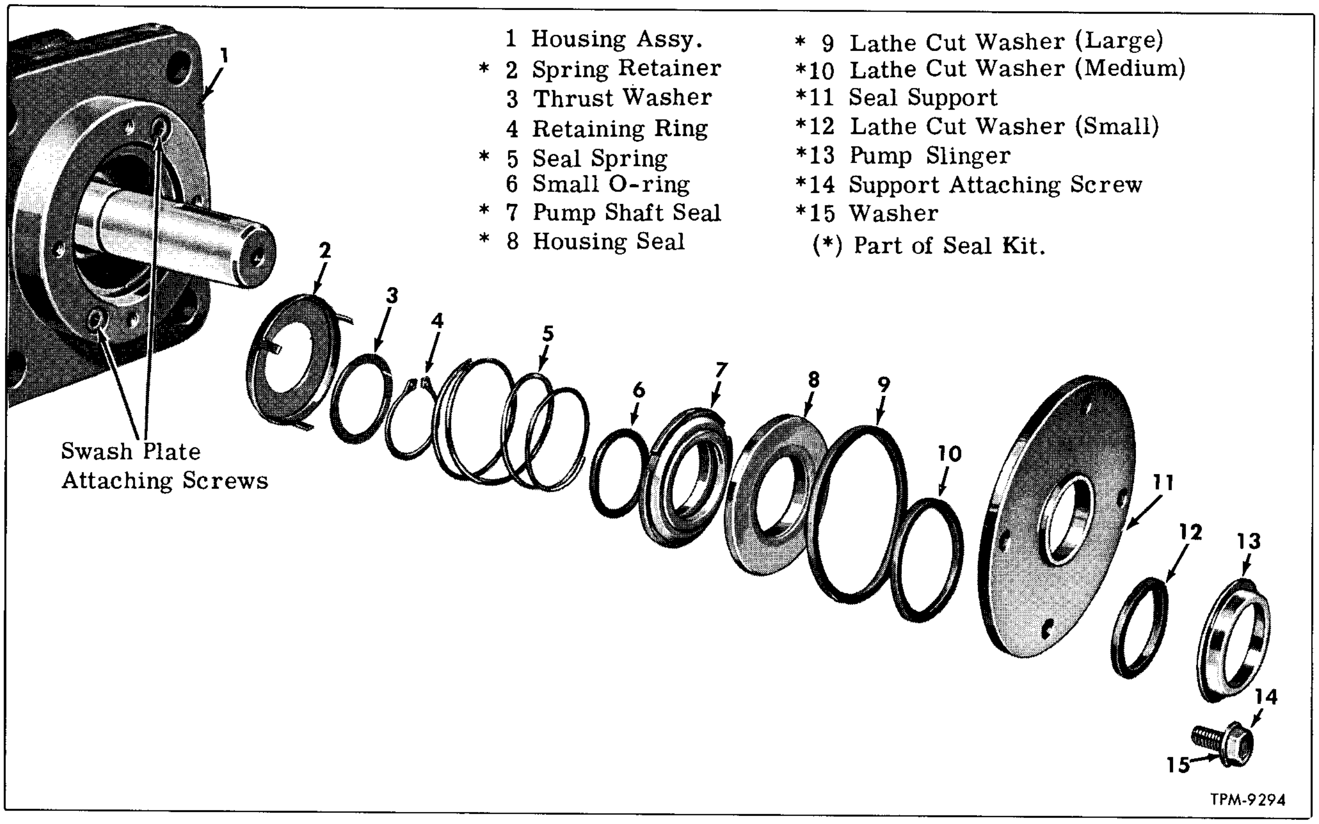


Figure 38—Motor Shaft Seal Components

INSTALLATION

NOTE: Motor shaft seal components are serviced in a kit only. DO NOT USE OLD PARTS.

IMPORTANT: APPLY CLEAN HYDRAULIC FLUID TO ALL COMPONENTS OF SEAL KIT PRIOR TO INSTALLING.

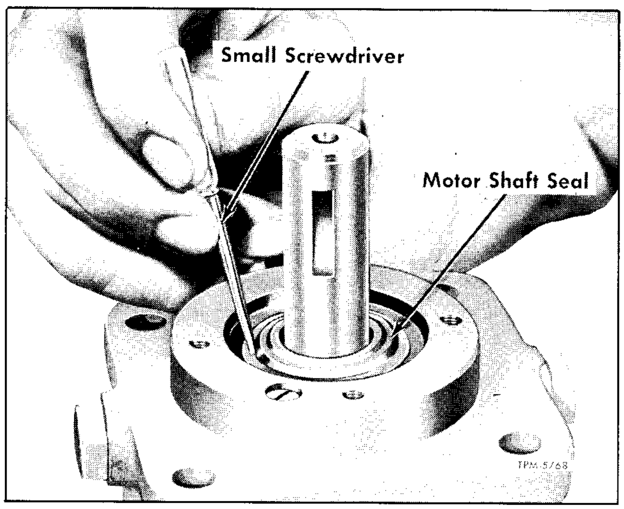


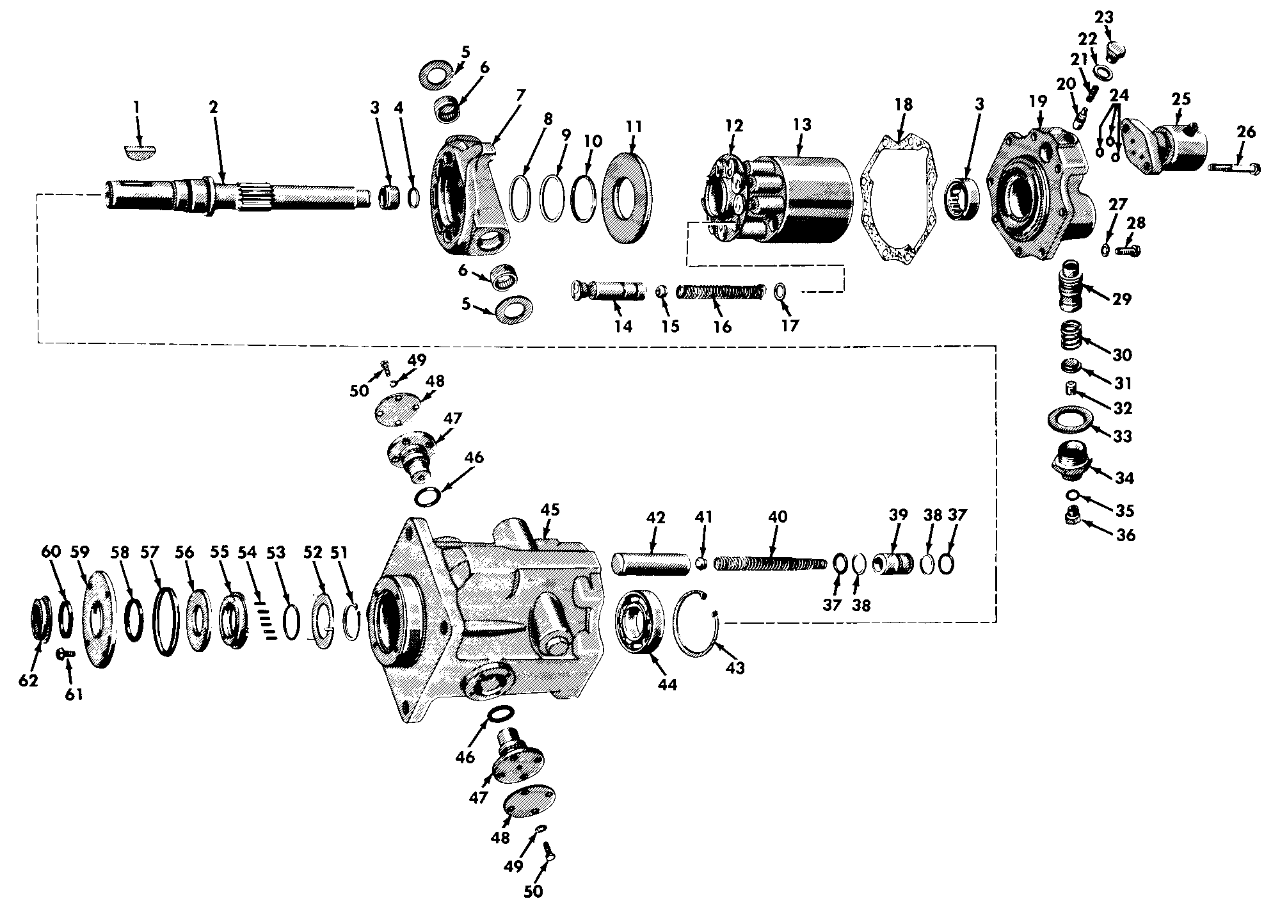
Figure 39—Method of Removing Motor Shaft Seal

NOTE: Key numbers in text refer to figure 38.

1. Examine and clean recess in motor housing.
2. Lower spring retainer (2) over shaft, into housing recess. IMPORTANT: Rotate retainer until it drops in place on flats of shaft.
3. Install thrust washer (3) and retaining ring (4). Make sure ring is fully seated in shaft groove.
4. Install seal spring (5) into recess.

NOTE: Make sure large end of spring is inserted first.

5. Insert O-ring (6) into internal groove of shaft seal (7), then apply grease to I.D. of O-ring.
6. Carefully lower shaft seal (7) with installed O-ring (6) over seal spring (5). Make sure sealing surface of seal (7) is located upward. Match three slots of seal with three prongs of spring retainer (2).
7. Position lathe cut washer (9) on O.D. of housing seal (8) with washer flush with surface opposite sealing face. Place a film of oil on O.D. of washer.
8. Place housing seal assembly (8) over shaft. Be sure sealing surface of seal is in the downward position. Center the seal assembly on shaft.
9. Put a small amount of clean grease into annular groove of motor seal support (11). Press lathe cut washer (10) into support groove.



1 Pulley Drive Key
2 Pump Drive Shaft
3 Shaft Rear Bearing Inner Race (Part of Complete Bearing Assy.)
4 Retaining Ring
5 Trunnion Thrust Washer
6 Trunnion Bearings
7 Swash Plate
8 Lock Ring (Spiral Type)
9 Shims (As Req'd.)
10 Thrust Washer
11 Thrust Plate
12 Piston Slipper Retainer
13 Cylinder Block
14 Piston Assy.
15 Piston Spring Seat
16 Piston Spring
17 Spring Washers
18 End Cap Gasket
19 End Cap Assy.
20 Dampening Valve
21 Dampening Valve Spring
22 Washer Assy.
23 Dampening Valve Plug
24 O-ring
25 Pump Solenoid Valve Assy.
26 Valve Attaching Bolt
27 End Cap Attaching Bolt
28 Bolt Washer
29 Flow Control Valve Assy.
30 Valve Outer Spring
31 Seat
32 Adjustment Screw Assy.
33 Plug Washer Assy.
34 Flow Control Valve Plug
35 Plug Gasket
36 Plug
37 O-ring
38 Back-up Washer
39 Transfer Bushing
40 Power Piston Spring
41 Spring Seat
42 Power Piston
43 Bearing Snap Ring
44 Shaft Front Bearing Assy.
45 Pump Housing
46 Trunnion O-ring
47 Swash Plate Trunnion
48 Trunnion Plate
49 Lock Washers
50 Screws
51 Snap Ring
52 Shaft Seal Retainer
53 O-ring
54 Spring
55 Pump Shaft Seal
56 Housing Seal
57 Lathe Cut Washer (Large)
58 Lathe Cut Washer (Medium)
59 Seal Support Assy.
60 Lathe Cut Washer (Small)
61 Screw and Washer
62 Shaft Slinger

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Figure 40—Disassembled View of Hydraulic Pump Assembly

SYSTEM MAINTENANCE

10. Position seal support assembly (11) to motor housing, pressing downward on support to seat the seal and washers, then attach support loosely with four screws (14) and washers (15).

11. Insert small lathe cut washer (12) into motor slinger (13). Place slinger with washer on shaft and press downward until washer contacts face of seal support.

12. Final tighten support attaching screws evenly. Check to see that slinger washer (12) is contacting support.

13. Install fan assembly as directed previously under "Fan Blade Replacement."

14. Operate system until fluid reaches normal operating temperature (5 to 10 min.). Fill, then check for leakage at seal.

FAN DRIVE PUMP OVERHAUL

NOTE

As unit is being disassembled, inspect for dirt, sludge, metallic shavings and for any other material or condition which may determine the cause of failure.

If during overhaul, internal failure is found and any metallic particles or impurities are present, it will be necessary to flush all fluid lines with kerosene and air pressure mixture before installing repaired or new unit.

IMPORTANT: ALL TOOLS, WORKING AREA, AND APPAREL MUST BE CLEAN WHEN SERVICING UNITS. IF WIPING CLOTHS ARE USED, MAKE SURE THEY ARE OF LINT-FREE TYPE. DIRT OR FOREIGN MATTER IN SYSTEM WILL CAUSE SHORT LIFE OF UNITS AND MAY CAUSE COMPLETE FAILURE OF SYSTEM.

CLEAN EXTERIOR SURFACES OF UNIT TO BE OVERHAULED BEFORE STARTING DISASSEMBLY PROCEDURES.

DISASSEMBLY OF FAN DRIVE PUMP

NOTE: Key numbers in text refer to figure 40.

1. Place the pump in a vise with shaft downward, grasping the pump by the hub. Using a 1-7/16 inch wrench, remove pump flow control valve plug and components (fig. 33) as directed previously under "Servicing Fan Drive Pump Flow Control Valve."

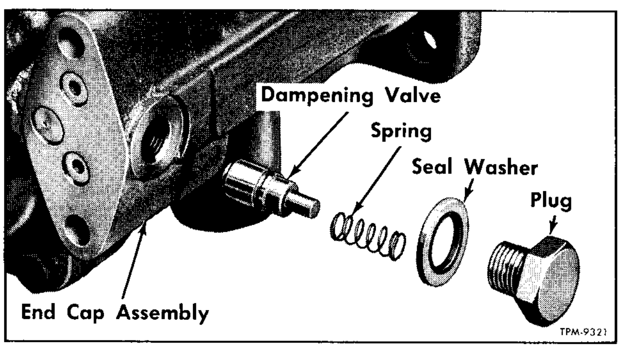


Figure 41—Pump Dampening Valve Components

2. Using a 3/4" wrench, remove dampening valve components (fig. 41) from pump end cap assembly. NOTE: Use needle-nose pliers to remove valve (20) from bore.

3. Remove solenoid valve components (fig. 35) from pump as instructed previously under "Pump Solenoid Valve Replacement and Repair."

4. Before removing pump end cap assembly (19), tool shown in right view of figure 42 should be made available. Tool can be improvised locally using dimensions shown. Use of this tool is necessary as end cap, which is under excessive spring pressure will follow heads of attaching bolts when being removed and may cause bolt threads to become stripped. Use tool as shown in left view of figure 42.

> **CAUTION**
>
> End cap valving or sealing surface that mates on the pump cylinder block (13) is a lapped surface. It should be relapped and cleaned thoroughly before reassembly.

5. SLIDE end cap (19) off cylinder block face. See figure 43 which shows cover removed. End cap gasket (18) can be removed from pump housing (45).

6. Referring to figure 43, pull or twist transfer bushing assembly (39) from end cap. Also lift power piston spring (40) from bore in housing.

7. Pour a small amount of solvent or kerosene into pump housing to break the hydrostatic seal on slipper heads of pistons (14).

8. While holding cylinder block from sliding out of housing, tip housing to drain off excess fluid. Place the pump horizontally on work bench. Turn the cylinder block (13) carefully out, then remove from housing as shown in figure 44.

9. Using a small screwdriver or a knife blade, remove lock ring (8) from groove of slipper retainer (12) as shown in figure 45. Shims (9), thrust washer (10), thrust plate (11) and slipper retainer (12) may then be removed. See figure 46 which shows parts removed.

10. Lift pistons (14), piston spring seats (15), piston springs (16), and spring washers (17) from

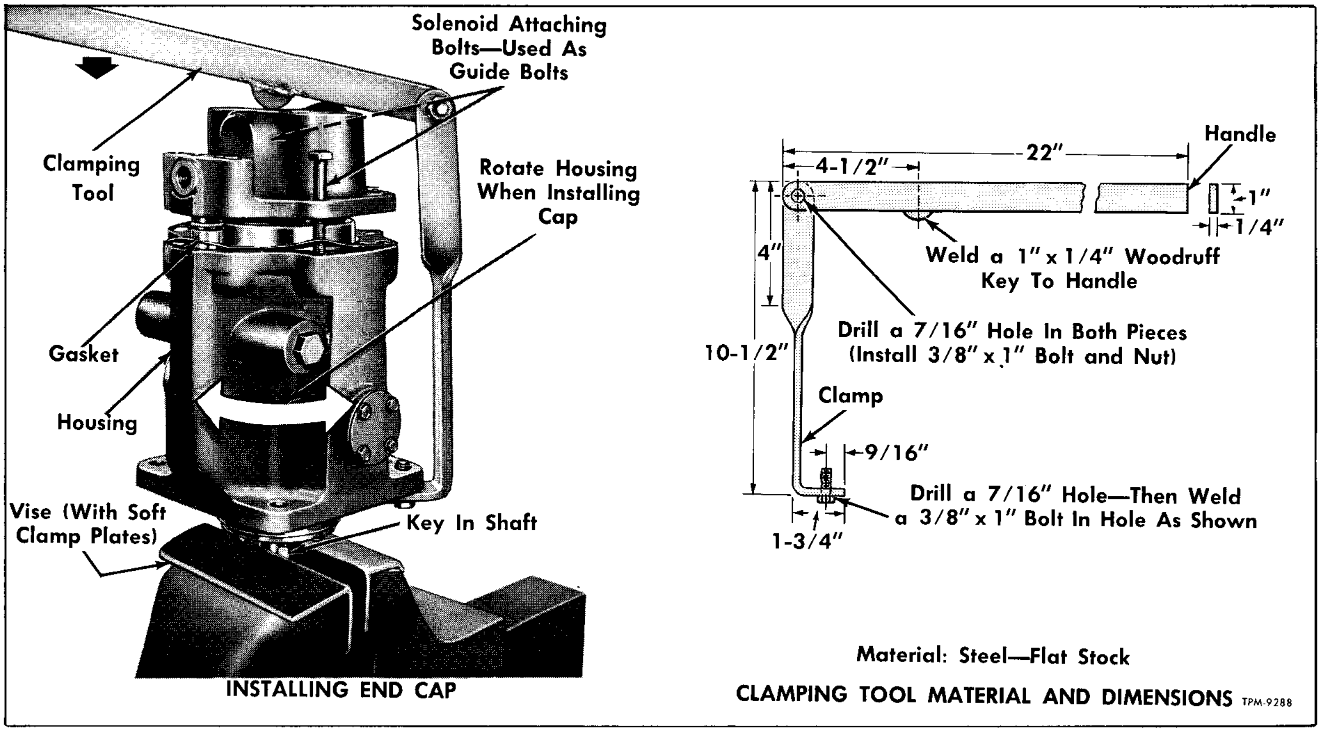


Figure 42—Using Clamp Tool To Replace Pump End Cap

cylinder bores.

11. If power piston (42) and spring seat (41) stayed in housing bore, tip housing to allow parts to slide from bore. NOTE: If power piston (42) is slightly sticky, it can be lightly polished and the power piston bore in housing cleaned. If piston is tightly stud in bore, solvent may be used to free piston. If piston can not be removed, a new housing and power piston assembly will be required.

IMPORTANT: After piston is removed, do not allow piston contact lug of swash plate (7) to contact piston bore within housing.

12. Remove pump shaft seal components (fig. 36) from pump and shaft as directed previously under "Pump Shaft Seal Replacement."

13. Using Tru-Arc pliers No. 2, remove drive shaft front bearing snap ring (43). With a soft hammer, tap keyway end o shaft (2) after making sure that swash plate (7) within housing will not interfere. Remove shaft assembly.

14. Remove four screws (50) which attach swash plate trunnion (47) and trunnion plate (48) on each side of pump housing.

IMPORTANT: Before removing trunnions, mark

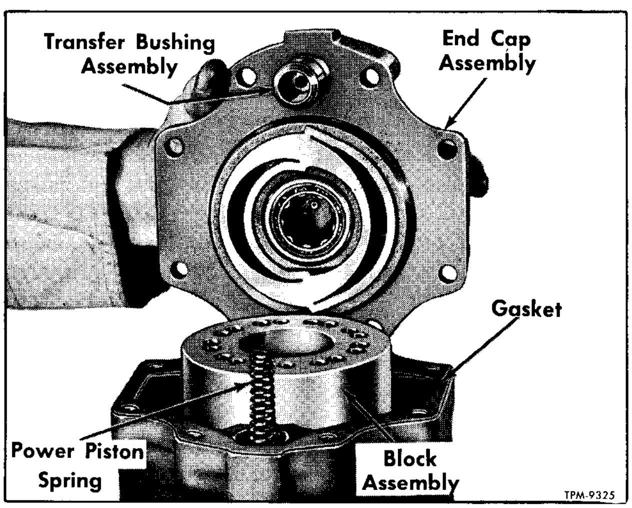


Figure 43—Pump End Cap Assembly Removed

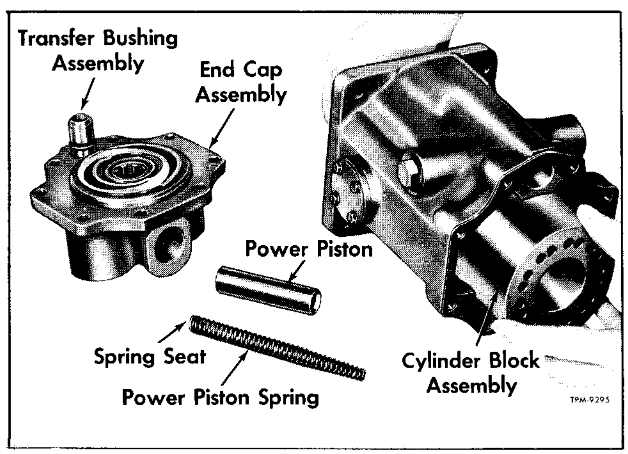


Figure 44—Replacing Pump Cylinder Block

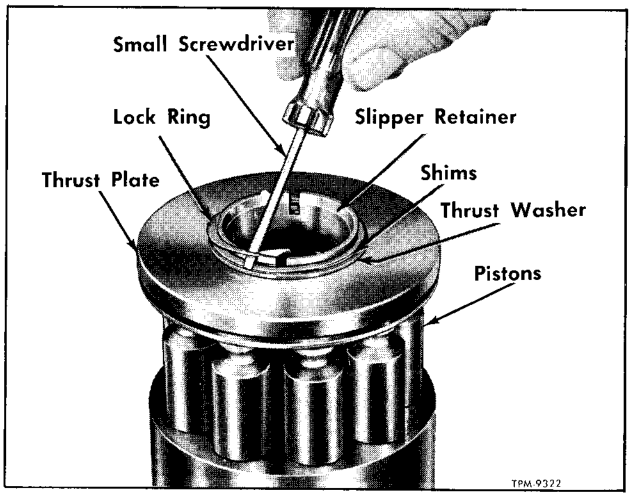


Figure 45—Removing Lock Ring From Pump Slipper Retainer

trunnion flange in relation to housing to assure original position when reassembling. Using a spanner wrench or similar tool, remove trunnions (47) being careful to support swash plate (7) while this is being done. Remove trunnion thrust washers (5) and swash plate from housing. The swash plate will have to be tipped slightly forward and turned while in an upright position, then rotated to be removed. See figure 47.

15. Remove O-rings (46) from each swash plate trunnion (47).

REPAIR OF FAN DRIVE PUMP

NOTE: Key numbers in text refer to figure 40.

1. If cylinder block (13) or end cap (19) sealing surfaces are grooved or scored, it will be necessary to lap surfaces of both parts in manner shown in figure 48. Use fine lapping compound. Use

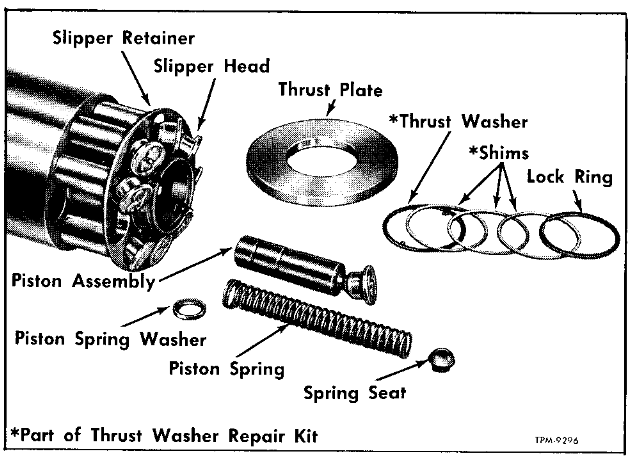


Figure 46—Pump Cylinder Block Disassembled

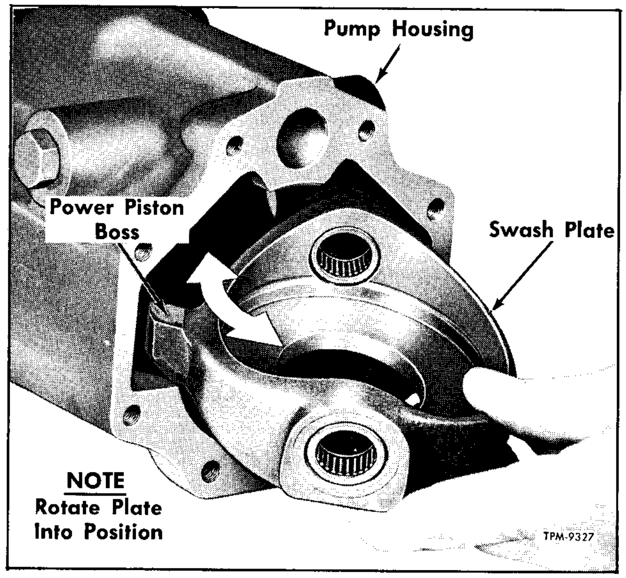


Figure 47—Replacing Pump Swash Plate

kerosene or solvent to thoroughly wash and clean parts including bores. Remove any lapping compound that may be present.

IMPORTANT: Do not remove over .005" stock from face of end cap. If necessary to remove more than this amount, it is recommended that end cap assembly be replaced with a new one.

2. Thrust plate (11) can be lapped in same manner if scored or grooved.

3. If pump shaft front support bearing (44) indicates wear or excessive play, it can be readily pressed from shaft and replaced after removing snap ring (51). If original bearing is to be used at assembly it should be thoroughly washed and cleaned with solvent or kerosene. Secure reinstalled bearing with snap ring (51).

4. If shaft rear bearing inner and outer race (3) are worn, replace bearing assembly by pulling old bearing outer race from end cap and pressing in a new bearing outer race in manner shown in figure 49.

IMPORTANT: DO NOT DAMAGE LAPPED SEALING SURFACES OF END CAP.

To replace the bearing inner race on pump shaft, remove race retaining ring (4) from shaft groove, then replace bearing race. NOTE: Make sure retaining ring is seated fully in shaft groove when reinstalling.

5. If necessary, trunnion bearings (6) in swash plate can be replaced in conventional manner. Make sure new bearings are clean before installing.

6. Clean, inspect, and if necessary replace any part which shows wear or scoring.

IMPORTANT: Wearing safety glass, direct high pressure air stream into all fluid passages and cavities of end cap (19) and housing (45).

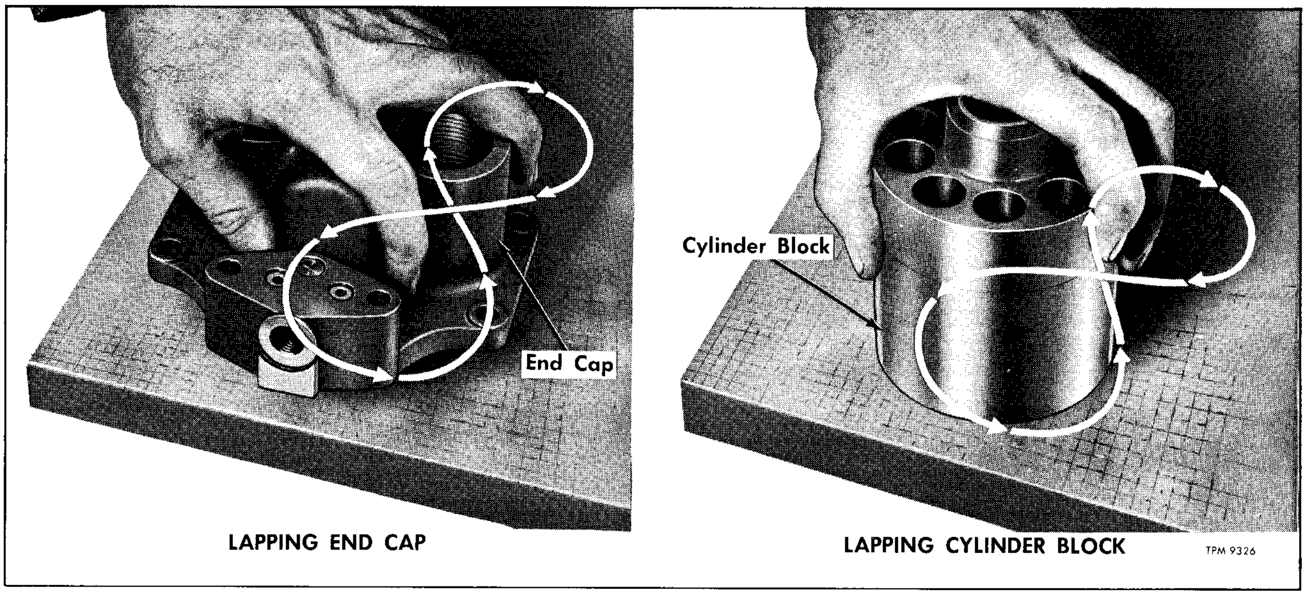


Figure 48—Lapping Pump Cylinder Block and End Cap

ASSEMBLY OF FAN DRIVE PUMP

NOTE: Key numbers in text refer to figure 40.

IMPORTANT: Make sure all parts and passages are absolutely clean before assembling pump.

1. Place swash plate (7) with assembled trunnion bearings (6) into pump housing as shown in figure 47. Note position of power piston lug on swash plate - must be facing up.
2. Inspect O-ring (46) on trunnions and replace if any nicks or scratches are present. Place O-ring on trunnion.
3. Note that trunnion (47) wear pattern is on one side of trunnion, and in reassembly this wear pattern should be placed so it faces the pulley end of the pump housing (45). This was the reason trunnions were marked prior to removal. Turn trunnions through thrust washers (5) and into swash plate bearings. Rotate trunnions to alignment marks made prior to removal, then install trunnion plate (48), and attach both with screws (50) and lock washers (49). Tighten screws evenly and firmly.
4. Place pump housing (45) into vise with hub downward grasping housing by the housing hub, then place pump shaft (2) into housing. Line up shaft for squareness and tap gently with soft hammer to drive the shaft and bearing into housing recess.

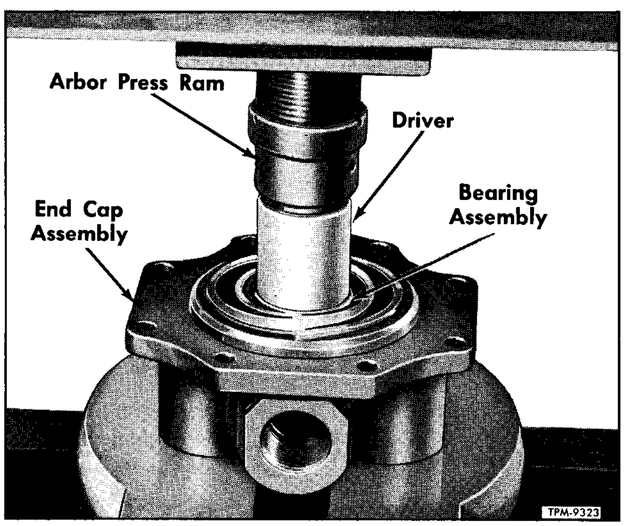


Figure 49—Installing New Bearing In End Cap

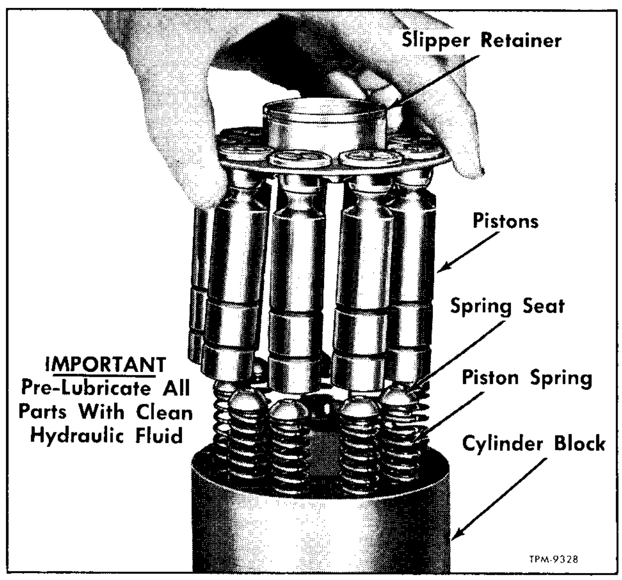


Figure 50—Installing Pump Pistons In Cylinder Block

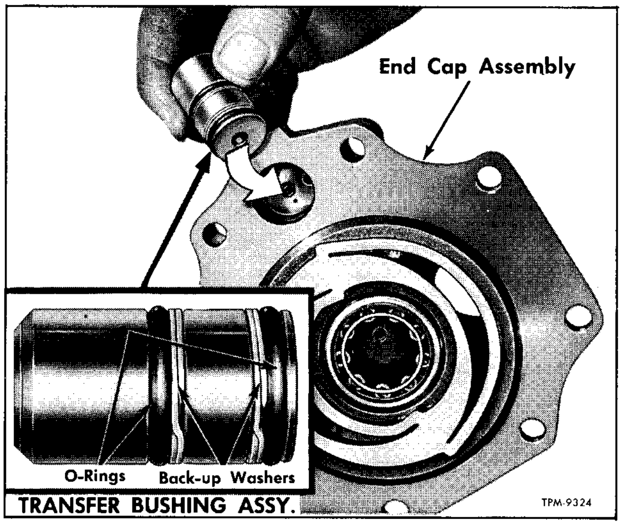


Figure 51—Installing Pump Transfer Bushing Assembly

IMPORTANT: Do not drive the shaft beyond the point of positioning. Install bearing snap ring (43). Make sure snap ring is fully seated in groove.

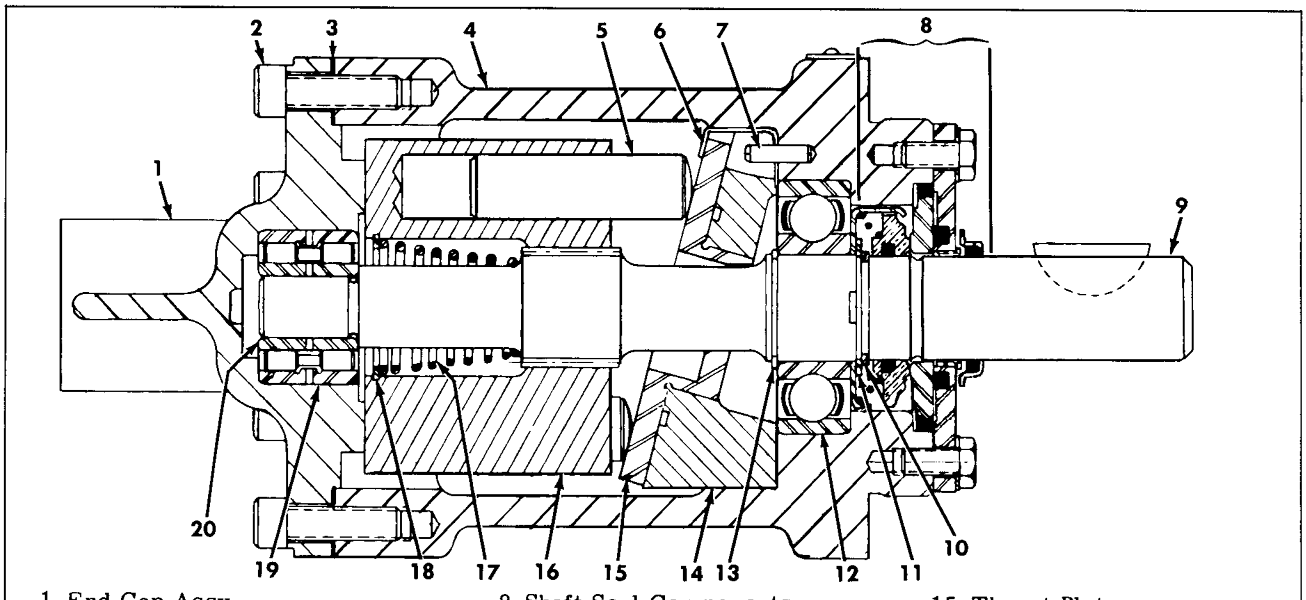
5. Prior to assembling pistons into block, oil all parts. Referring to figure 50, assemble piston springs (16) and spring seats (15), into cylinder block (13), then with pistons located in slipper retainer (12) as shown, lower pistons over springs and down into cylinder block. IMPORTANT: Pistons and block should be of same temperature, otherwise it may be impossible to install pistons in cylinder bores. DO NOT ATTEMPT TO FORCE PISTONS IN BLOCK.

6. Referring to figure 46, assemble thrust washer (10), shims (9), and spiraloc snap ring (8) over end of slipper retainer. NOTE: Thrust washer tangs must engage slots on slipper retainer (12).

IMPORTANT: Shims (9) are available in .005" and .015" thickness. Select shims to obtain a clearance of .001" to .005" between thrust washer (10) and thrust plate (11).

7. Insert cylinder block assembly (13) into pump housing (45) with the pump placed on the work bench in a horizontal position. As cylinder block is placed into housing, turn shaft so that splines will engage splines of cylinder block. Press block into housing.

8. With pump housing still in horizontal position, insert power piston spring seat (41) into end of spring (40), then place power piston (42) over seat and spring. Insert piston assembly into housing bore.



1 End Cap Assy.
2 Screws
3 Cap Gasket
4 Motor Housing
5 Pistons
6 Thrust Plate Clip Retainer
7 Pin (locating)
8 Shaft Seal Components
9 Motor Drive Shaft
10 Retaining Ring
11 Thrust Washer
12 Main Bearing Assy.
13 Snap Ring
14 Swash Plate
15 Thrust Plate
16 Cylinder Block Assy.
17 Tension Spring
18 Retainer Ring
19 End Cap Bearing Assy.
20 Bearing Inner Race

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Figure 52—Sectional View of Drive Motor Assembly

9. Referring to figure 51, inspect transfer bushing O-rings (37) and back-up washers (38) for collapsed or scuffed condition. Replace if necessary. Install O-rings and back-up washers on bushing, then insert transfer bushing assembly into end cap as shown.

10. Place pump in vise with shaft downward. Clamp vise jaws on pump shaft. Assemble housing gasket (18) to pump housing. Grease rollers in end cap bearing (3) packing grease to the outside to allow clearance for inner bearing race on the shaft.

11. CAREFULLY place end cap (19) against cylinder block (45).

IMPORTANT: DO NOT SCRATCH OR NICK SEALING OR VALVING SURFACES OF EITHER PART.

12. Using the two solenoid attaching bolts (26) as guide bolts, compress cap assembly slowly downward using improvised compressing tool (fig. 42). NOTE: Rotate pump housing slightly. This will facilitate alignment of shaft with bearing in the end cap. Install and tighten end cap attaching screws evenly and firmly.

13. Install flow control valve components (fig. 33) into bore of end cap assembly as instructed previously under "Servicing Fan Drive Pump Flow Control Valve."

14. Referring to figure 41, reassemble dampening valve components into bore of end cap. Tighten valve plug firmly.

15. Install pump shaft seal components to housing and shaft as instructed previously under "Pump Shaft Seal Replacement."

16. Install pump solenoid components (fig. 35) as instructed previously under "Pump Solenoid Valve Replacement and Repair."

FAN DRIVE MOTOR OVERHAUL

NOTE

As unit is being disassembled, inspect for dirt, sludge, metallic shavings and for any other material or condition which may determine the cause of failure.

If during overhaul internal failure is found and any metallic particles or impurities are present, it will be necessary to flush all fluid lines with kerosene and air pressure mixture before installing repaired or new unit.

IMPORTANT: ALL TOOLS, WORKING AREA, AND APPAREL MUST BE CLEAN WHEN SERVICING UNITS. IF WIPING CLOTHS ARE USED, MAKE SURE THEY ARE OF LINT-FREE TYPE. DIRT OR FOREIGN MATTER IN SYSTEM WILL CAUSE SHORT LIFE OF UNITS AND MAY CAUSE COMPLETE FAILURE OF SYSTEM.

CLEAN EXTERIOR SURFACES OF UNIT TO BE OVERHAULED BEFORE STARTING DISASSEMBLY PROCEDURES.

DISASSEMBLY OF FAN DRIVE MOTOR

NOTE: Key numbers in text refer to figure 52.

1. Place motor with shaft downward in a vise, then remove six screws (2) (using 3/16" hex-wrench) which attach end cap assembly (1) to motor housing (4). Carefully lift end cap from motor housing. DO NOT SCUFF OR DAMAGE SEALING SURFACES OF CAP OR CYLINDER BLOCK. Figure 53 shows end cap assembly separated from housing.

2. Remove end cap gasket (3) and two small O-rings from recesses in housing at fluid passages. See figure 53 which shows rings installed.

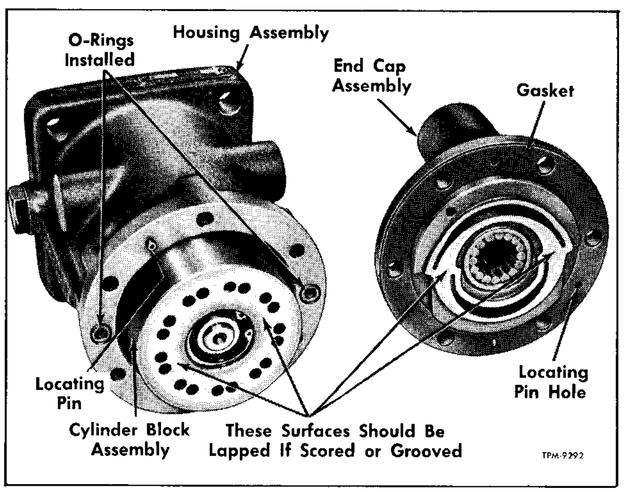


Figure 53—Motor End Cap Assembly Removed

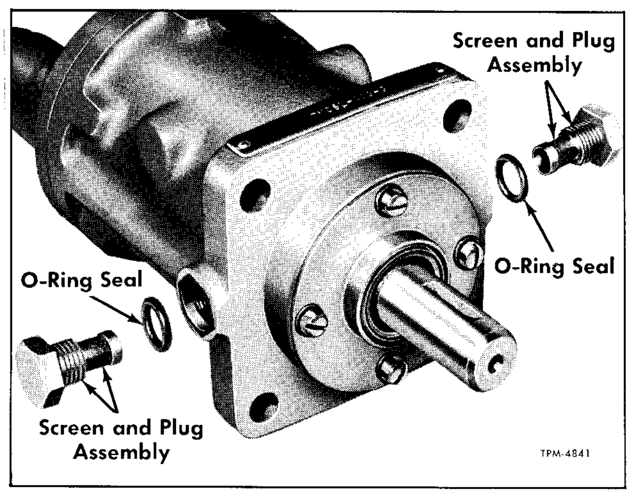


Figure 54—Motor Oil Strainer Plugs and Screens Removed

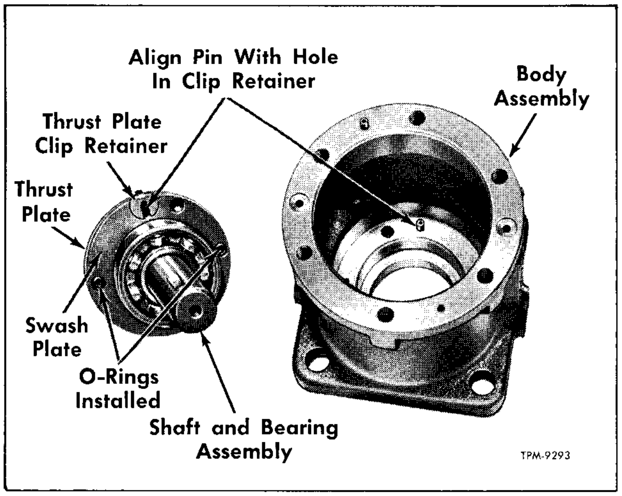


Figure 55—Motor Shaft Assembly Removed

3. With motor housing in horizontal position, slide cylinder block assembly (16) from housing.

NOTE: Pistons (5) in cylinder block are all the same size and are interchangeable.

4. Using a Tru-Arc pliers, remove retainer ring (18) and tension spring (17) from cylinder block.

5. Referring to figure 54, remove oil strainer plug and screen assemblies from sides of motor housing.

IMPORTANT: Make sure that any grit present is not left in motor housing.

6. Remove seal components (8) from motor shaft as previously explained under "Motor Shaft Seal Replacement."

7. Using a 3/16" hex-wrench, remove two screws and copper washers from shaft end of housing which retain swash plate (14) and drive shaft within the housing. Attaching screws are shown installed in figure 38.

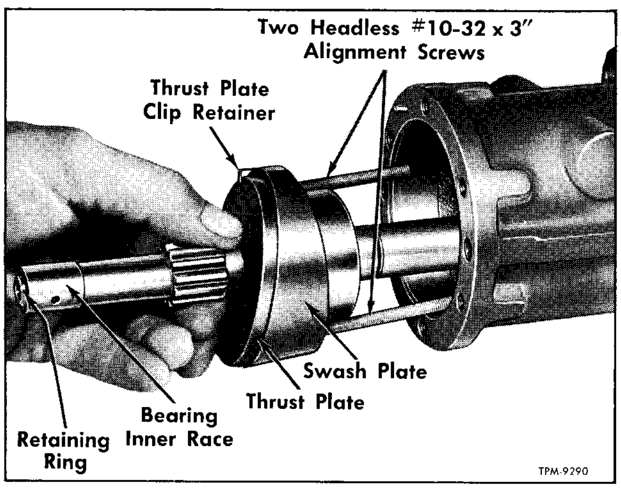


Figure 56—Installing Motor Shaft Assembly

8. Using a soft hammer, tap on fan end of motor shaft to drive the shaft with thrust plate (15) and swash plate (14) as an assembly from motor housing. Figure 55 shows shaft assembly separated from housing.

9. Remove clip retainer (6) which retains thrust plate (15) to swash plate (14), then remove thrust plate and swash plate from over shaft splines.

10. Press shaft bearing assembly (12) from motor shaft.

REPAIR OF FAN DRIVE MOTOR

NOTE: Key numbers in text refer to figure 52.

1. If cylinder block (16) or end cap (1) sealing surfaces are grooved or scored, it will be necessary to lap surfaces of both parts as shown typically in figure 48. Use fine lapping compound. Use kerosene or solvent to thoroughly wash and clean parts including bores, and remove any lapping compound that may be present on the sealing or valving surfaces.

IMPORTANT: Do not remove over .005" stock from face of end cap (1). If necessary to remove more than .005" it is recommended that end cap assembly be replaced with a new one.

2. The motor thrust plate (15) can be resurfaced in similar manner as cylinder block and end cap. Remove all lapping compound before assembling.

3. Check small O-rings on back of swash plate (fig. 55) for nicks and scratches, then lightly grease for reassembly making sure they are completely in recess.

4. If bearing (19) in end cap or bearing inner race (20) on motor shaft is worn it will be necessary to replace the end cap assembly (1).

ASSEMBLY OF FAN DRIVE MOTOR

NOTE: Key numbers in text refer to figure 52.

IMPORTANT: Make sure all parts and passages are absolutely clean before assembling motor.

1. Press bearing assembly (12) on shaft against snap ring (13).

2. Referring to figure 56, position swash plate (14) and thrust plate (15) over shaft spline and assemble clip retainer (6) as shown.

3. Cut off heads of two No. 10-32 x 3 inch screws and install into screw holes on back side of swash plate as shown in figure 56. These screws will serve as guide pins to align mounting bolt holes and fluid passages.

4. Refer to figure 55 which shows alignment pin (7) at bottom of motor housing. Pin must align with thrust plate clip retainer hole. Assemble shaft assembly into motor housing. Remove one guide screw at a time and install regular attaching screws

with copper washer. Tighten screws evenly. Tap end of shaft to seat bearing in housing recess, then final tighten screws firmly.

5. After cleaning pistons (5) lubricate, then install in cylinder block (16) as shown infigure 57.

6. Assemble complete cylinder block assembly into the housing, turning the motor shaft (9) to engage the spline arrangement.

7. Align new gasket (3) onto housing face using holes for line up.

8. Clean and inspect the two small O-rings and insert into recess on housing face (see fig. 53). Check to see if check valve assembly is in place in the outlet part of end cap assembly. Install end cap (1) using guide pin in face of housing for proper line-up.

9. Assemble seal components (8) over shaft and into housing recess as described previously under "Motor Shaft Seal Replacement."

10. Clean oil strainer plug and screen assemblies, then with O-ring on each plug, install plugs in sides of pump housing. See figure 54.

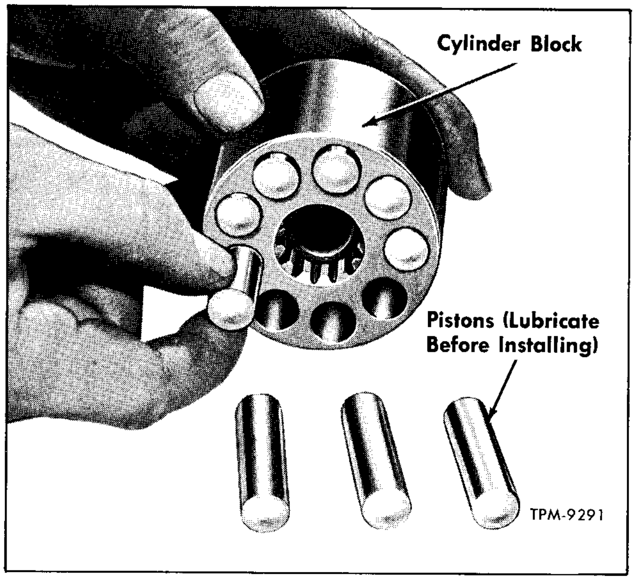


Figure 57—Installing Motor Pistons

CONDENSER FAN DRIVE SYSTEM
TROUBLESHOOTING CHART

Condition	Possible Cause	Recommendation
Pump stops operating	1. Air bound pump.	1. Make sure fluid reservoir is full to "OIL LEVEL" mark and that fluid is free of impurities. IMPORTANT: DO NOT OVERFILL.
		2. Crack pump outlet line connection to vent air out of hollow pistons within pump, then disconnect wire from pump solenoid terminal. Operate system until fluid only appears at line connection. IMPORTANT: Be sure solenoid wire is disconnected.
	2. Loose drive belts.	Tighten belts to obtain 1/4" to 3/8" deflection across all three belts, midway between pulleys. IMPORTANT: DO NOT OVERTIGHTEN BELTS AS FAILURE OF PUMP SHAFT BEARING COULD RESULT.
	3. Electrical circuit to pump solenoid closed.	With system in operation, disconnect wire from terminal on pump solenoid valve. Pump should build up pressure. If pressure builds up, the malfunction is electrical. Check wiring diagram since solenoid must be "dead" for pump to operate. NOTE: Contacts of pump air pressure switch may be frozen or burned together. If this is the case, replace air pressure switch. Switch is located on forward bulkhead in air conditioning compressor compartment.

SYSTEM MAINTENANCE

TROUBLESHOOTING CHART (CONT.)

Condition	Possible Cause	Recommendation
Pump stops operating (Cont'd.)	4. Needle valve in pump solenoid held open by an obstruction.	Valve should close in a short period of time (1 to 1-1/2 seconds) after system is placed in operation. If valve does not close, the build-up of pump pressure will not occur. Disconnect wire at solenoid terminal, then remove and repair solenoid valve assembly as instructed previously under "Pump Solenoid Valve, Replacement and Repair." NOTE: After installing solenoid valve components, it will be necessary to vent fluid system at pump.
Fan motor will not operate	1. Insufficient fluid in system.	Fill reservoir to "OIL LEVEL" mark.
	2. Dirt or foreign particles in system fluid.	Drain, flush, and refill system with CLEAN fluid.
		NOTE: System can be flushed out using a mixture of kerosene and air pressure. Final flush lines using air pressure only.
	3. Defective fluid pump or motor.	Repair and/or replace pump or motor assembly.
	4. Defective pump solenoid valve air pressure switch.	Replace switch. A defective switch (contacts stuck closed) will cause solenoid valve to stay open, thus permitting pump to operate in no-pressure position.
Fan motor noisy	1. Dislodged check valve in motor.	Replace pump end cap assembly. NOTE: Check valve is not serviced separately.
	2. Air in fluid system.	1. Check fluid level in reservoir. Add fluid if necessary to "OIL LEVEL" mark.
		2. Clean out small vent holes in fluid reservoir cover and cover nut.
		3. Vent all lines at pump connections.
Fan motor operates below 1775 rpm - or motor surges	1. Insufficient fluid in system.	Replenish fluid to "OIL LEVEL" mark in fluid reservoir.
	2. Clogged or restricted fluid return line to pump.	Remove restriction or if necessary, replace line. NOTE: Check inner lining of all hoses for possible deterioration.
	3. Sticking flow control valve at fluid pump.	Remove and clean valve components. Refer to "Servicing Fan Drive Pump Flow Control Valve," explained previously.
	4. Worn pistons or valving surfaces in either the pump or motor.	Overhaul or replace defective unit.

REFRIGERANT COMPRESSOR

The refrigerant compressor, platform-mounted under rear of coach (fig. 58) is a four-cylinder reciprocating type unit. It is self-lubricated and self-contained. The shaft seal is of the rotary type, consisting of a stationary lapped seal face ring pressed into the seal cover, with a spring-loaded rotating carbon nose ring sealing against the seal face of the stationary ring.

A neoprene seal ring between the carbon nose ring and spring acts as a seal around the shaft. The seal faces are flood-oiled under pressure at all times. A sight glass on the side of the compressor shows the oil level. Shut-off valves are provided at the compressor suction and discharge ports.

Compressor is also equipped with an integral and completely internal mechanism which allows the compressor to start with two of the four cylinders unloaded. Loading and unloading of these two cylinders is actuated by suction pressure variations, but the unloader mechanism operates hydraulically on power from the oil pressure of the compressor lubricating system. Without oil pressure the unloader mechanism holds suction valves open and individual cylinders operate unloaded. Under oil pressure the unloader permits suction valves to function normally and cylinders to operate at full capacity.

After shut-down and without oil pressure, the two cylinders will start and operate unloaded until oil pressure is supplied to the unloader mechanism. For detail information on unloading operation refer to "Cylinder Unloading Operation" explained later.

Compressor is shaft driven from coach engine by an air-operated clutch. Clutch can be engaged

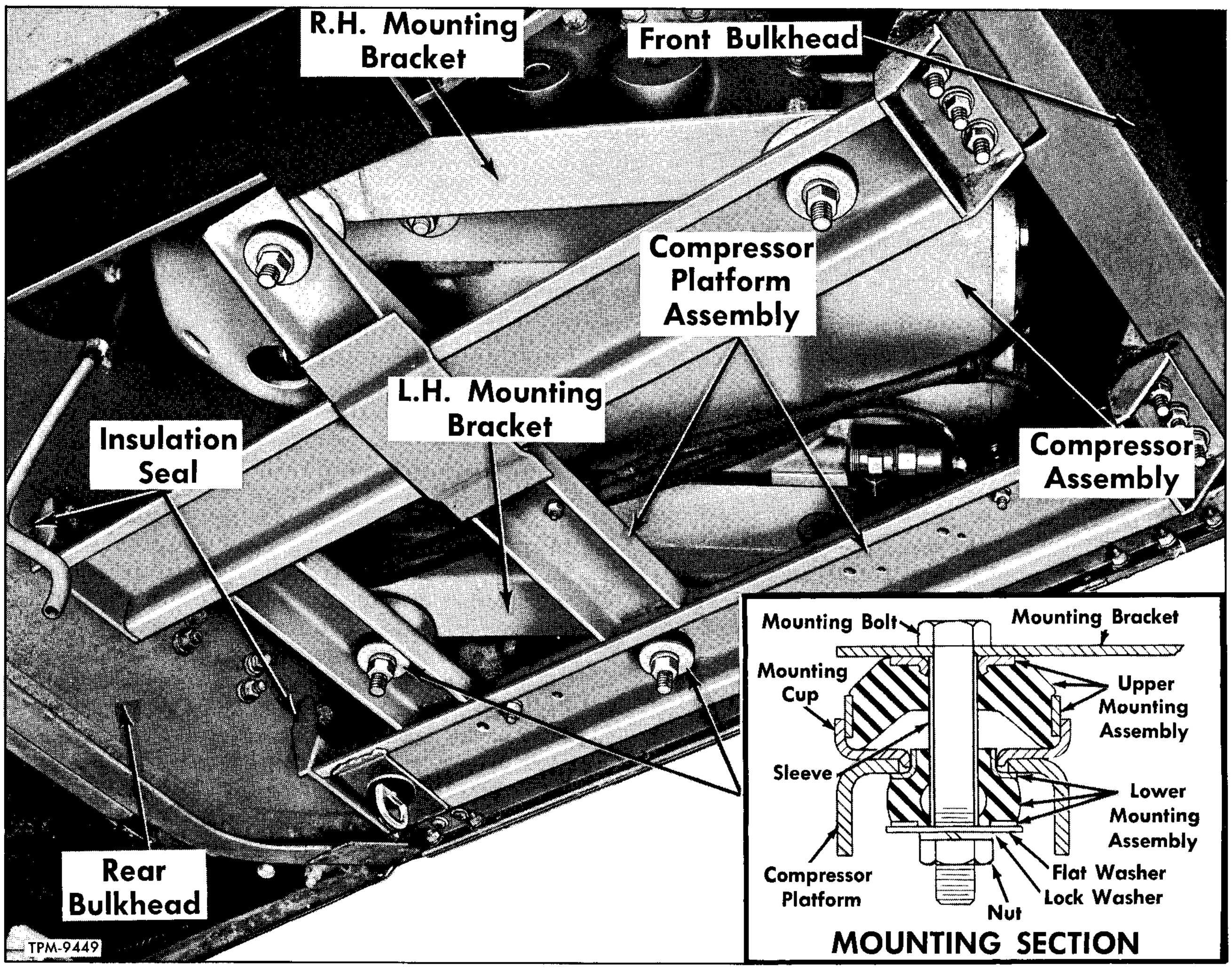


Figure 58—Compressor and Platform Mounting (Typical)

SYSTEM MAINTENANCE

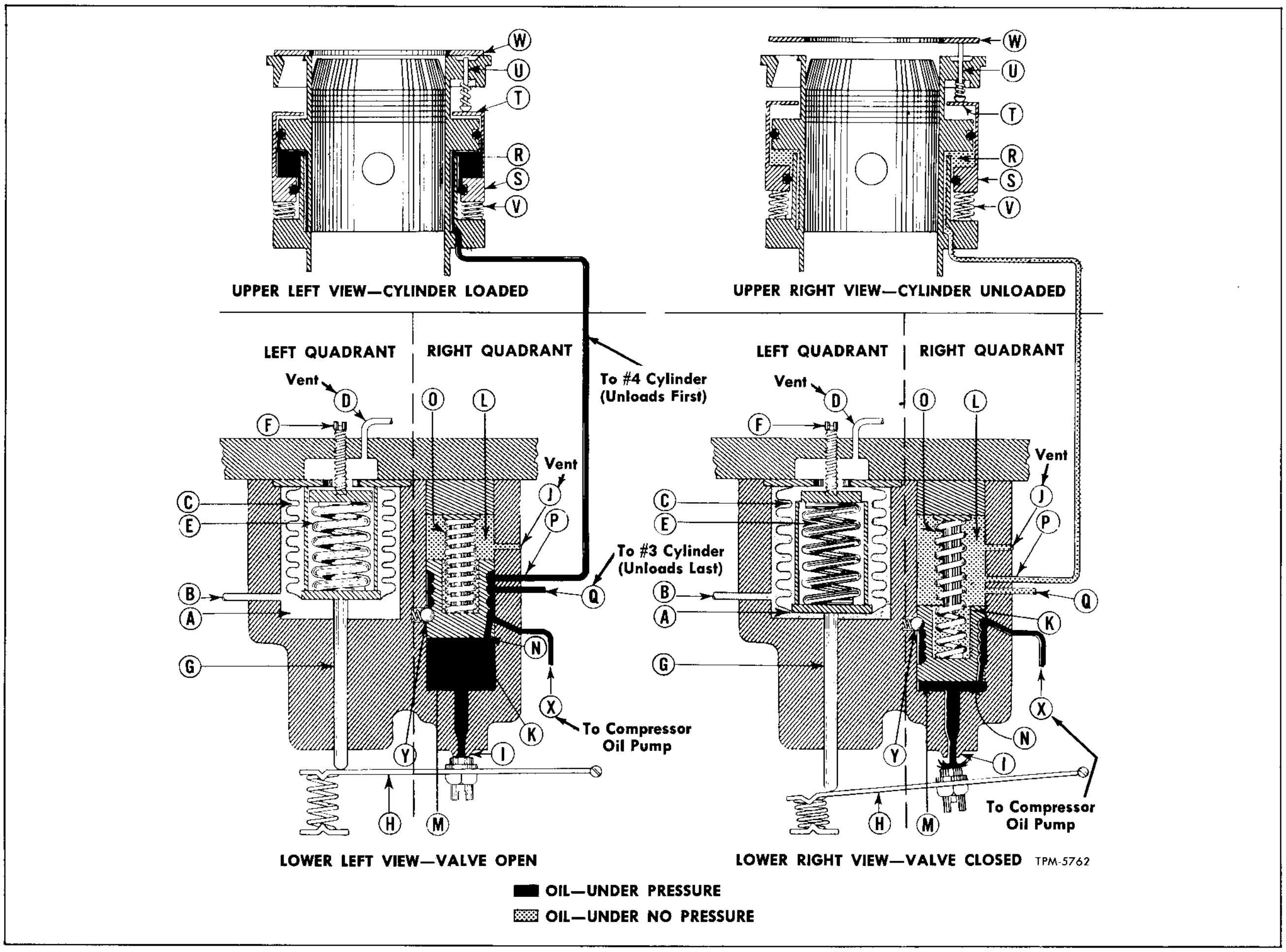


Figure 59—Compressor Capacity Control and Unloader Starting System

when engine is operating in a range between 3 psi and 15 psi oil pressure. The clutch operation and maintenance information is explained later under respective headings.

Compressor can be removed from coach with clutch mechanism attached. Removal procedures are explained later under "Compressor Replacement." Compressor overhaul instructions are also explained later under "Refrigerant Compressor Overhaul."

COMPRESSOR OPERATION

NOTE: Figure 65 shown later under "Refrigerant Compressor Overhaul" shows sectional view of compressor.

The aluminum body of the compressor is divided into three main sections -- the discharge or high pressure gas cavity, the suction or low pressure gas cavity, and the crankcase.

Low pressure refrigerant gas is drawn into the compressor from the suction line. As the refrigerant gas enters the compressor it passes through fine mesh strainer screens and then into the suction cavity. In the suction cavity, oil entrained with the refrigerant separates from the refrigerant and passes into the crankcase through a check valve. The low pressure refrigerant is drawn into the cylinder during the down-stroke of the piston through the cylinder suction valve which is mounted on the top of the cylinder liner. During the suction stroke of the piston, the cylinder discharge valve in cage on top of cylinder liner is closed. As the piston begins its compression stroke, the cylinder suction valve closes and compression begins. As the piston moves up on the compression stroke, the cylinder discharge valve opens, and the high pressure refrigerant gas passes through the valve into the discharge cavity. The gas then passes through the discharge cavity to the high pressure refrigerant line. A spring-loaded safety relief valve is mounted in the wall which divides the high and low sides of the compressor. This valve serves to relieve or bypass discharge pressure to the low side of the compressor should the discharge pressure build up normally high or above the set point of the high to low relief valve. Such a

condition would occur if the compressor was operated with the discharge line shut-off valve closed. No. 3 and 4 cylinders of compressor are equipped with unloader mechanism. Operation of mechanism is explained as follows:

CYLINDER UNLOADING OPERATION

The cylinder unloading control mechanism consists of two distinct groups of components: The capacity control actuator and the cylinder unloader components. These two components are schematically shown in figure 59. Upper views show the cylinder unloader mechanism and the lower views show the capacity actuator components.

Capacity Control Actuator

The capacity control actuator reacts to variations of refrigeration load requirements and transmits them to the cylinder unloader mechanisms which act to load and unload two of the four compressor cylinders. To perform this dual function, the capacity control actuator consists of a pressure sensing device which is sensitive to variation in suction pressure, and valving mechanism which regulates the oil pressure to the various cylinder unloader mechanisms.

Pressure Sensing Device (Refer to Left Quadrant in Lower Views on Figure 59)

The pressure sensing device consists of a chamber A, connected to suction pressure through line B, and a bellows C, the inside of which is connected to atmospheric pressure through vent D. The tendency of the pressure sensing device is to maintain as nearly as possible a predetermined suction pressure. This pressure is the maximum pressure required to satisfy the system and may range from 0 to 50 psi. The specific point is maintained by a balance of forces - suction pressure balanced against a combination of atmosphere pressure and force from spring E. The amount of tension is adjustable by set screw F. When the system requires less than full refrigeration load, the suction pressure will fall below the predetermined point, causing an unbalance within the device, and the unloading cycle will commence. The drop in suction pressure permits bellows C to expand, forcing plunger G against lever H moving it downward. The downward movement of this lever opens the regulated orifice I. The opening and closing of this orifice controls the action of the valving mechanism.

Valving Mechanism (Refer to Right Quadrant in Lower Views on Figure 59)

The function of the valving mechanism is to supply each of the cylinder unloaders with oil under pump pressure when full compressor capacity is required and to relieve this pressure when cylinders are to operate unloaded. This valving mechanism consists of a hydraulic cylinder containing an annularly grooved, floating piston K. The annular grooves are constantly connected to oil pump pressure through line X.

Above the piston is a chamber L which is vented to the crankcase through orifice J. Below the piston is another chamber M connected to the annular grooves in the piston by orifice N and connected to crankcase pressure through regulated orifice I. Located within the hydraulic cylinder is a spring O which tends to move the floating piston toward the lower chamber.

Under full capacity operation, as shown in lower left view of figure 59, regulated orifice I is shut off; oil pressure in lower chamber M increases because oil under pump pressure is being supplied through orifice N. This pressure overcomes the force of spring O and floating piston K rises in the cylinder. As it rises, the annular grooves in the floating piston coincide in sequence with lines P and Q to the cylinder unloaders, providing them with full oil pressure and permitting them to operate at full capacity.

When full compressor capacity is not required, regulated orifice I is opened through movement of lever; oil bleeds through and pressure within lower chamber approaches crankcase pressure as shown in lower right view of figure 59. Under these circumstances, the force of spring O overcomes the pressure in the lower chamber and floating piston K is moved downward so that lines P and Q become connected in sequence to crankcase pressure through orifice J. The spring-loaded detent ball Y permits the piston to move only in distinct detents; one groove at a time.

In this manner, the valving mechanism supplies or withdraws from each cylinder unloader the oil pressure that operates the unloader mechanism.

Unloader Cylinder Mechanism

When oil from the forced feed lubricating system flows through line P, from the valving mechanism to the cylinder unloader, it enters annular chamber R. The inner wall or unloader cylinder is firmly anchored to the cylinder liner; the unloader piston S, however, is free to move. The up and down movement of this unloader piston raises and lowers take-up ring T which raises and lowers suction valve lift pins U.

Under full capacity operation as shown in lower left view of figure 59, oil flows into annular chamber R under pressure sufficient to contract the unloader piston springs V. When oil pressure forces springs to contract, the unloader piston S moves down and take-up ring T and the suction valve lift pins U move with it. This permits the suction valve W to function normally and the cylinder operates at full capacity. When the compressor is to operate

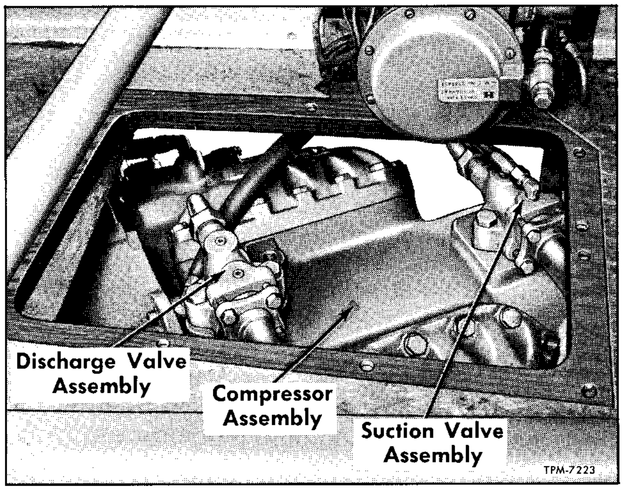


Figure 60—Access Opening To Compressor Valves (All Transit Model Coaches)

at less than full capacity as shown in lower right view of figure 59, oil line P from the cylinder unloader mechanism is connected to crankcase pressure through orifice J which allows the pressure in the annular chamber R to dissipate; the cylinder unloader springs V expand, lifting the unloader piston S. This raises the take-up ring T, the valve lift pins U, and holds the suction valve W open so that the controlled cylinder is operating in an unloaded condition.

COMPRESSOR MAINTENANCE

Compressor requires practically no maintenance other than making sure that sufficient (but not too much) oil and refrigerant is maintained in the system at all times. The lubrication system of the compressor will fail if the system loses its charge of oil or refrigerant. Both oil and refrigerant must be circulating through the compressor whenever it is running to prevent very serious damage. Check compressor mounting bolts periodically. Check carefully for indication of oil or refrigerant leakage. Leaks should be remedied promptly to prevent excessive refrigerant and oil loss. If necessary, compressor can be overhauled as explained later under "Refrigerant Compressor Overhaul."

COMPRESSOR LUBRICATION

The compressor crankcase serves as a reservoir for the main oil charge. A portion of the lubricating oil circulates with the refrigerant, and this oil is separated from the refrigerant as the refrigerant passes through the suction cavity of the compressor. As the low pressure refrigerant and oil separate in the suction chamber, the oil goes to the bottom of the chamber, and the gas goes to the top of the chamber. The oil passes from the

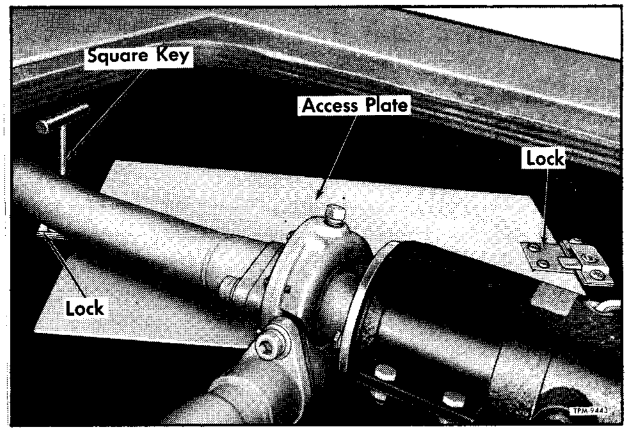


Figure 61—Access Opening To Compressor Valves (All Suburban Model Coaches)

suction chamber to the crankcase through a check valve in the crankcase wall. This check valve allows oil to flow into the crankcase from the suction cavity, but checks against the flow of oil out of the crankcase.

During the "OFF" cycle of the compressor, refrigerant tends to collect and condense in the crankcase. The liquid refrigerant mixes with the oil in the crankcase. When the compressor begins to operate, there is a rapid reduction of pressure in the crankcase above the oil level. This permits the liquid refrigerant to evaporate out of the oil. As the refrigerant boils off and leaves the crankcase, the oil tends to foam and leave with the refrigerant. To prevent serious loss of crankcase oil on start-up, the refrigerant leaving the crankcase passes through a fine bronze screen or foam breaker. The foam breaker separates the oil from the refrigerant and returns the oil through a passage to the crankcase.

Compressor lubrication is accomplished by a force feed, direct drive, positive displacement pump, which is mounted to the end of the crankshaft. The pump is not self-reversing and must be operated in one direction of rotation. Oil from the crankcase is drawn into the pump through a tube which connects the pump to a fine mesh strainer located in the sump of the crankcase. This strainer scavenges oil from the bottom of the crankcase and prevents the entrance of foreign particles into the oil circulating system.

The pump then draws oil past a magnetic plug which attracts steel particles that escaped through strainer. Pump forces oil into suction end main bearing after which it enters end of crankshaft. Crankshaft oil passages are arranged to feed from inside of crankshaft throw. Two magnetic plugs in crankshaft oil passages trap steel particles. Oil escapes between rod bearings and is converted into mist to lubricate wrist pins and cylinder walls.

Small cup and hole in top of each connecting rod allows lubricant to travel down through this hole to lubricate the piston pin.

Oil also flows from drive end of crankshaft into crankshaft seal chamber. Pump also forces oil through two small lines to No. 3 and 4 cylinder unloaders.

It is highly important that only the recommended refrigeration compressor oils which contain a de-foamant be used in this compressor. The approved oils for use in this compressor are listed in "AIR CONDITIONING LUBRICATION AND INSPECTION" later in this group. These oils can be obtained locally through refrigeration equipment suppliers. Oil should be purchased in sealed cans only. Never use bulk oil or oil which has been exposed to air.

IMPORTANT: USE ONLY APPROVED COMPRESSOR OILS.

The initial charge of oil in the compressor is 14 pints. After the compressor has been operated for about 30 minutes, the oil level should be about 1/4 to 1/2 of the way up on the compressor sight glass. If oil is near or below the bottom of the sight glass, oil should be added. The oil level should always be checked with the compressor operating. Before adding oil, first determine and correct cause of loss of oil.

A new compressor or one having been overhauled should be drained and refilled after the first 200 hours of operation. Refer to "SYSTEM SERVICES AND TESTS" for adding and draining of compressor oil.

COMPRESSOR SHUT-OFF VALVES

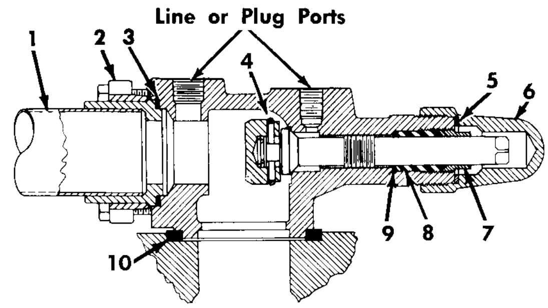
Double-seating shut-off valves are provided at the compressor discharge and suction ports. Valves are accessible from compressor compartment or through an access opening in floor (figs. 60 and 61). With both valve stems turned all the way in (closed), compressor is isolated from the rest of the system. "Operating Position" of valves, frequently referred to in this section is with the valve stem in the full back-seated position as shown in figure 62. NOTE: On these coaches it should never be necessary to place valves in the off back-seated position.

IMPORTANT: Valve caps with gaskets must be in place and tight at all times during system operation.

COMPRESSOR STORAGE

1. If compressor is to remain inoperative in coach for an extended period, a considerable amount of refrigerant could be lost through the shaft seal, because the shaft seal did not remain wetted. To prevent loss of refrigerant through the shaft seal, the compressor, suction, and discharge service valves should be closed (frontseated). This will isolate the compressor from the rest of the system. Another method of preventing loss of refrigerant through the compressor shaft seal when the compressor is idle for a long period of time, is to operate it every four or five days. This will maintain a film of oil on the sealing surfaces of the seal and on the bearings.

2. If compressor is removed from coach and is to remain in storage, stand the compressor on end, drive end down, on blocks in such a way that no weight rests on the compressor shaft.



1 Refrigerant Line
2 Flange Ring
3 Gasket
4 Valve and Stem Assy.
5 Cap Gasket
6 Cap
7 Packing Nut
8 Packing
9 Packing Washer
10 Gasket

TPM-9454

Figure 62—Compressor Refrigerant Valves (Typical)

COMPRESSOR REPLACEMENT

NOTE: Compressor which can be readily removed from compressor compartment is removed with the clutch assembly attached. Before removing compressor, pump down the system as directed later under "Pumping Down the System." It is also necessary to disconnect the hydraulic fluid lines from condenser fan pump if pump is to be removed with compressor.

COMPRESSOR REMOVAL PROCEDURE

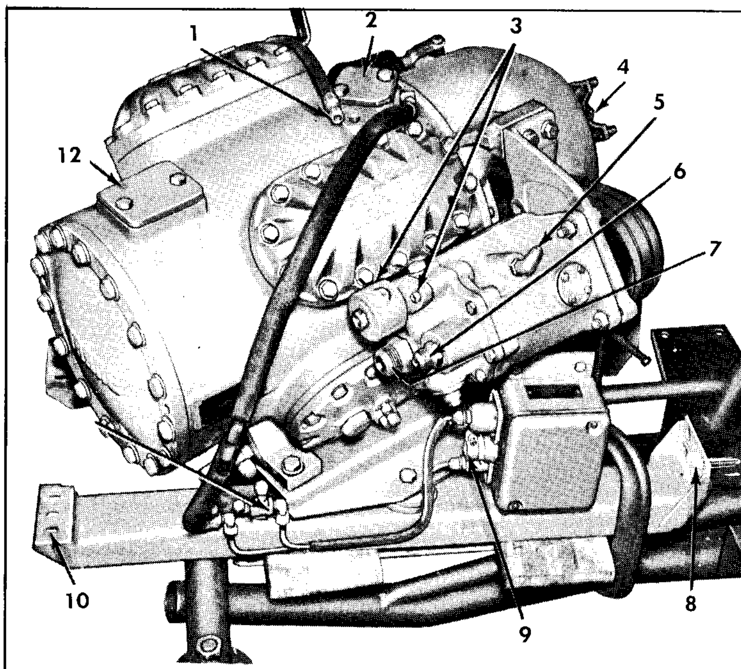
NOTE: Position rear wheels of coach on run-up blocks to provide sufficient clearance of compressor when removing. Key numbers in text refer to figure 63.

1. Remove clutch control air line (1) from air solenoid valve.

2. Disconnect compressor drive shaft (4) from clutch shaft flange.

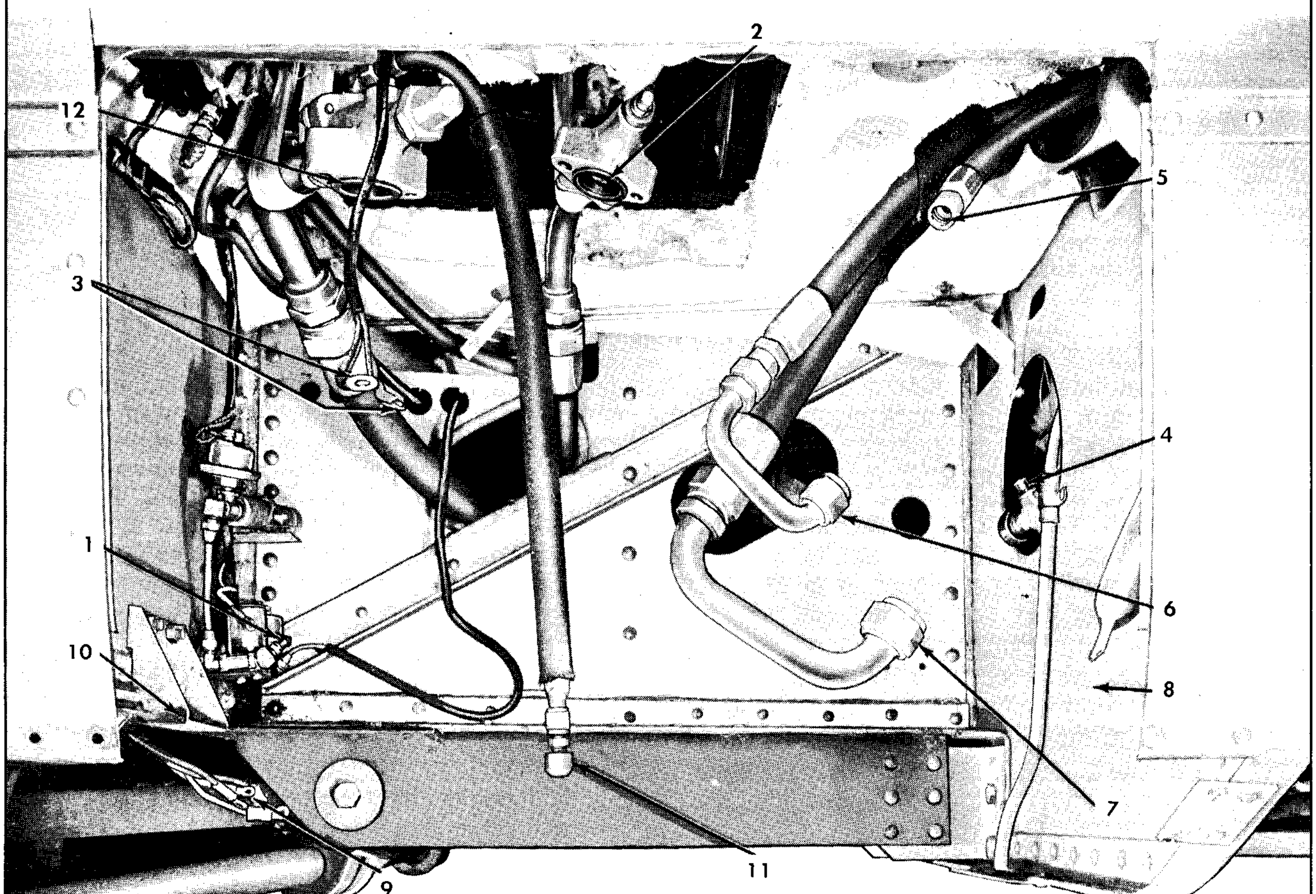
3. Drain condenser fan drive fluid system as instructed earlier under "Condenser Fan Pump Replacement," then disconnect hydraulic fluid lines

SYSTEM MAINTENANCE



1 Clutch Control Air Supply Line Connection
2 Refrigerant Discharge Valve Connection
3 Condenser Fan Pump Solenoid Wiring Connection
4 Compressor Drive Flange Connection
5 Fan Pump Vent Port to Fluid Reservoir
6 Fan Pump "OUT" Port Line to Fan Motor
7 Fan Pump "IN" Port Line from Fluid Reservoir
8 Platform Rear Mounting Bolt Holes
9 "HI-LOW" Pressure Switch Wiring Connection
10 Platform Front Mounting Bolt Holes
11 Suction Valve Line to Service Fitting Connection
12 Refrigerant Suction Valve Connection

DISCONNECT POINTS AT COMPRESSOR



DISCONNECT POINTS IN COMPARTMENT

TPM-7230

Figure 63—Compressor Disconnect Points (Typical)

(5, 6 and 7) from condenser fan pump. Disconnect wiring at pump solenoid.

4. NOTE: The following procedures cover method whereby the refrigerant lines with valves are disconnected from compressor. Close valves by turning stem clockwise, then remove bolts attaching valves to compressor. Raise and tie lines up out of the way. The compressor valve openings should be immediately covered with improvised blank flange plates and gaskets after removing the valves. This will retain some refrigerant in lines and compressor thus minimizing the entry of air and moisture. Figure 64 shows dimensions of closure plates which can be improvised locally.

5. Disconnect "HI-LO" pressure switch suction line (11) at suction valve test fitting. If "HI-LO" pressure switch is mounted on bulkhead, disconnect both lines at test gauge fittings. IMMEDIATELY SEAL ENDS OF ALL LINES AND CAP OPEN FITTINGS.

6. Remove dust shield from below compressor then position a lifting dolly to support weight of compressor unit. IMPORTANT: Make sure weight of compressor unit is distributed equally on lifting dolly. If possible, attach compressor to dolly.

7. Remove bolts, nuts, and washers which attach ends of compressor platform to coach body. Carefully lower compressor from compartment. Figure 63 shows compressor disconnect points.

8. Platform rubber mountings can be readily removed.

9. Compressor clutch unit can be removed from compressor as explained later under "Compressor Drive Clutch." Compressor overhaul procedure is also explained later under "Refrigerant Compressor Overhaul."

COMPRESSOR INSTALLATION PROCEDURE

NOTE: Key numbers in text refer to figure 63.

1. Referring to figure 58, install compressor rubber mounting components to compressor platform if previously removed.

2. Raise compressor assembly with mounting platform to position in compressor compartment. With insulation strip installed at each mounting, install mounting bolts through holes (8 and 10) in compressor platform and secure with flat washer,

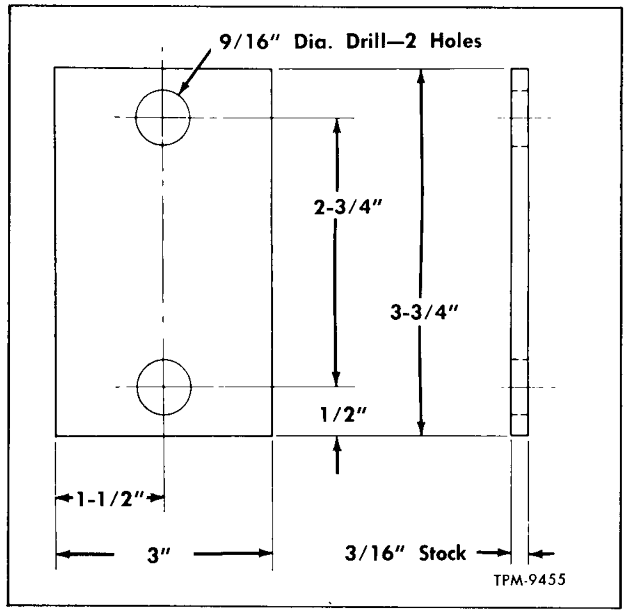


Figure 64—Closure Plates (For Placing Over Compressor Valve Ports)

lock washer, and nut. Tighten nuts of all mounting bolts firmly.

3. Install valves to compressor using new gaskets. Tighten valve attaching bolts evenly and firmly.

4. Connect "HI-LO" pressure switch lines to fittings (if previously disconnected).

5. Connect condenser fan pump lines (5, 6, and 7) to pump, using new O-ring gaskets. Refer to instructions explained previously under "Condenser Fan Drive Pump Replacement."

6. Install compressor drive shaft assembly. Tighten flange bolt nuts firmly.

7. Install clutch control air supply line (1) to air solenoid valve. Tighten connection firmly.

8. Install electrical wiring to terminal of fan pump solenoid and to ground.

9. Accomplish services outlined later under "SYSTEM SERVICES AND TESTS." See "Refrigerant Valves," "Preparing Unit For Operation," "Purging the System," "Testing for Leaks," and "Checking For Air in System."

REFRIGERANT COMPRESSOR OVERHAUL

Before overhauling compressor (fig. 65), the system must be pumped down and the unit removed from coach. Pumping down system instructions are explained later under "SYSTEM SERVICES AND TESTS." See "Pumping Down The System." Instruction procedures for removing compressor are explained previously under "Compressor Replacement."

The immediate area in which the compressor is to be overhauled should be dust-free and if pieces of cloth are to be used for the cleaning of parts, they should be of the lint-free type.

When servicing parts of compressor, handle the parts carefully and protect them against rusting immediately upon removal from compressor housing. Before installing parts, wash with refrig-

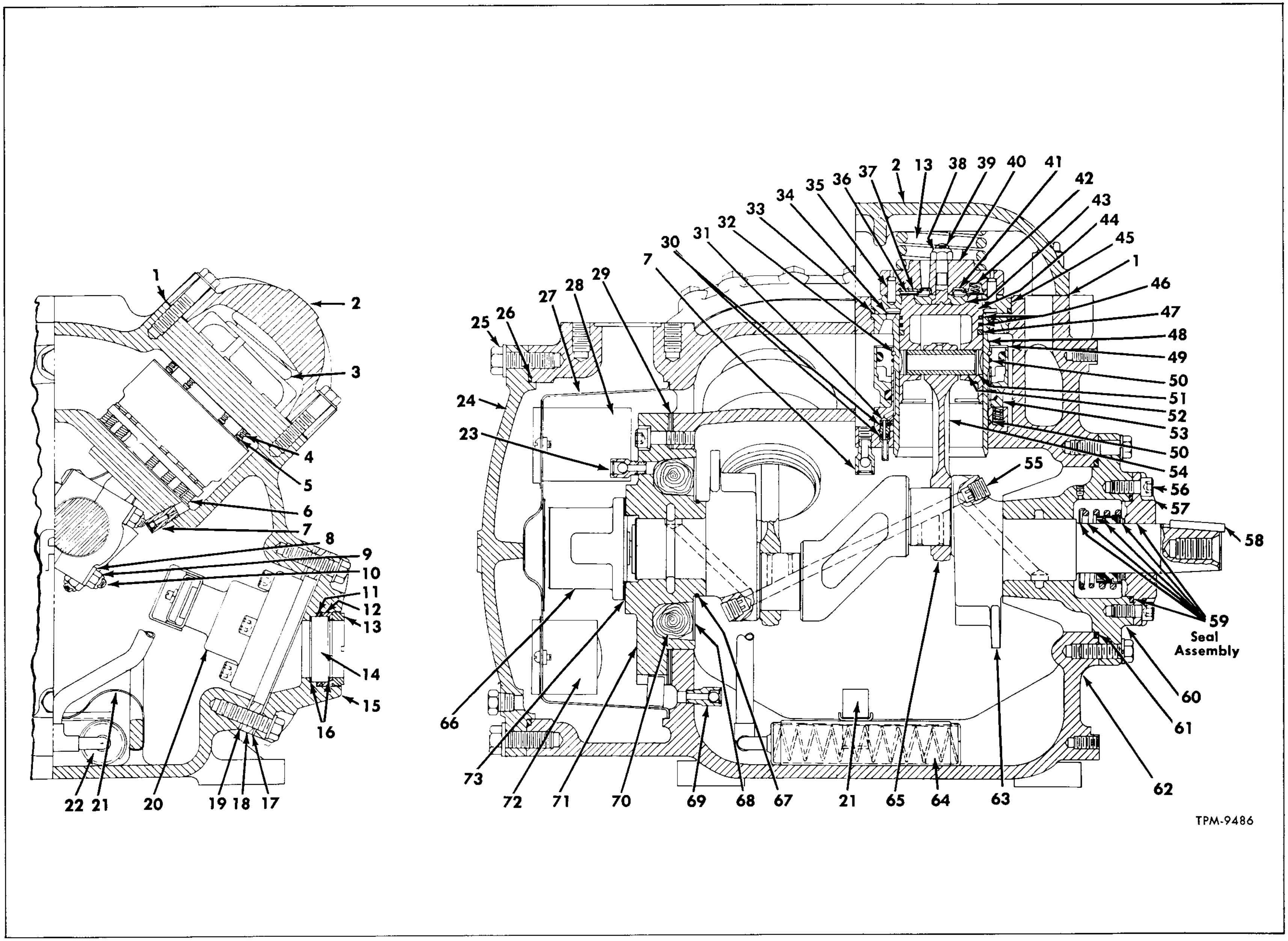


Figure 65—Refrigerant Compressor Assembly

1 Cylinder Head Gasket	21 Hold-down Retainer	40 Discharge Valve Cage	58 Drive Key
2 Cylinder Head	22 Crankcase Oil Strainer Assembly	41 Cushion Retainer	59 Crankshaft Seal Kit Assembly
3 Safety Head Spring	23 Check Valve Assembly	42 Discharge Valve Spring	60 Front Bearing Head
4 Lift Pin Spring	24 Suction Cover	43 Valve Seat	61 O-ring Seal
5 Lift Pin	25 Cover Bolt	44 Piston	62 Compressor Housing
6 Unloader Pin	26 Cover O-ring	45 Valve Plate	63 Crankshaft
7 Check Valve Assembly	27 Suction Strainer Pan Assy.	46 Piston Upper Rings	64 Crankcase Oil Strainer Assembly
8 Flat Washer	28 Suction Strainer Screen	47 Piston Lower Ring	65 Connecting Rod Cap
9 Nut	29 Shims (.010" and .015")	48 Cylinder Liner	66 Oil Pump Assembly
10 Bolt	30 O-ring Seal	49 Take-up Ring	67 Retaining Ring
11 O-ring Seal	31 Oil Connector	50 O-ring Seal	68 End Ring
12 Seal Ring	32 Retaining Ring	51 Snap Ring	69 Crankcase Oil Check Valve Assembly
13 Sight Glass Nut	33 O-ring Seal	52 Piston Pin	70 Foam Breaker Screen
14 Sight Glass	34 Suction Valve	53 Unloader Assembly	71 Rear Bearing Head
15 Handhole Cover	35 Dowel Pin	54 Connecting Rod	72 Oil Filter Assembly
16 Gasket	36 Discharge Valve Ring	55 Magnetic Plugs	73 Pump Gasket
17 Plate Gasket	37 Cushion	56 Cap Screws	
18 Capacity Control Plate	38 Nut	57 Seal Cover Plate (Part of Seal Kit - Key 59)	
19 Cover Gasket	39 Discharge Valve Bolt		
20 Capacity Control Assembly			

Captions For Figure 65

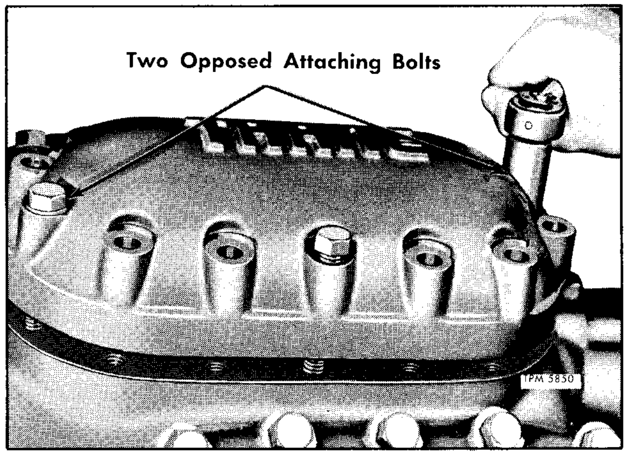


Figure 66—Method of Removing Cylinder Head Cover

eration compressor parts cleaner, then oil with new (clean) compressor oil. This applies especially to seal and bearing surfaces to prevent seizure when unit is first put in operation. Use new O-ring seals and gaskets at build-up of compressor.

The design of compressor permits the replacement of many components and sub-assemblies without having to disassemble balance of compressor. For example the cylinder liner can be replaced without having to remove piston and rod. However, the overhaul procedures described herein covers the complete disassembly of compressor in logical sequence and to the extent recommended by the manufacturer.

NOTE: When overhauling compressor, refer to "Compressor Wear Rate Table" under "Specifications" at end of this section.

NOTE: Cylinders marked 3 and 4 are equipped with unloader mechanism. Cylinders are marked on compressor housing.

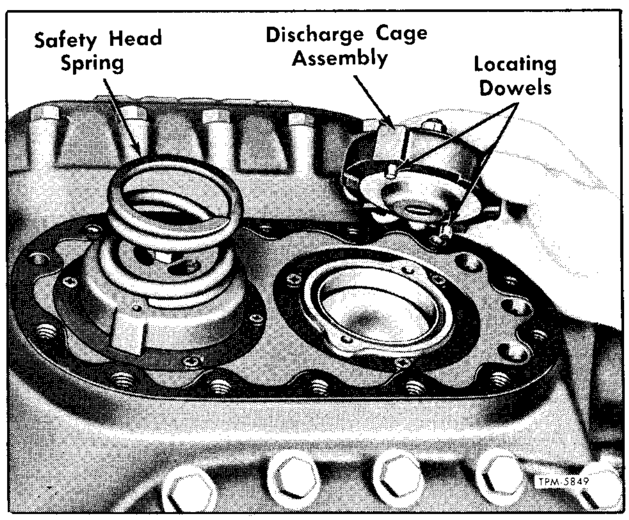


Figure 67—Removing Discharge Cage Assembly

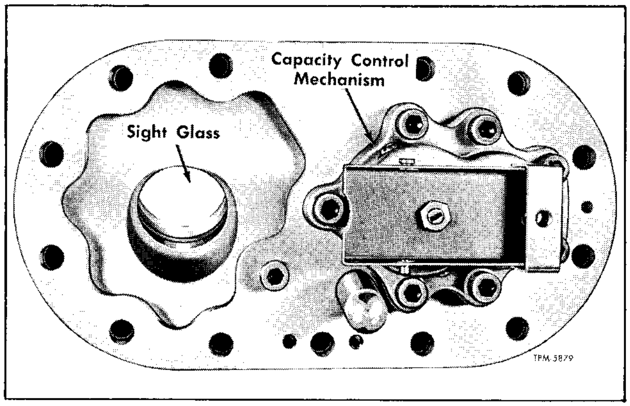


Figure 68—Handhole Cover With Capacity Control Assembly

COMPRESSOR DISASSEMBLY

CYLINDER HEAD AND DISCHARGE VALVE REMOVAL AND DISASSEMBLY

NOTE: Key numbers in text refer to figure 65.

1. Remove all but two opposed cylinder head attaching bolts. Back off remaining bolts two or three full turns (fig. 66).

2. Examine cylinder head (2) to see if head is following heads of attaching bolts as shown. If not, tap the head with a plastic hammer until head gasket (1) breaks loose.

3. As an aid in determining how far the bolts must be turned until they are freed of the tapped holes, a third bolt can be threaded (2 turns) into top center hole. This bolt will serve as an indicator as to how far opposed bolts can be turned out before becoming free of tapped holes.

4. Slowly and alternately remove two cylinder head end bolts, then the top center bolt. Remove head. Lift off safety head springs (3) and remove head gasket (1).

5. Lift discharge valve assembly from compressor (fig. 67).

6. Remove lock nut (38) from discharge valve bolt (39). Remove bolt and valve seat (43). Separate discharge valve ring, five springs, cushion retainer, and cushion from discharge valve cage.

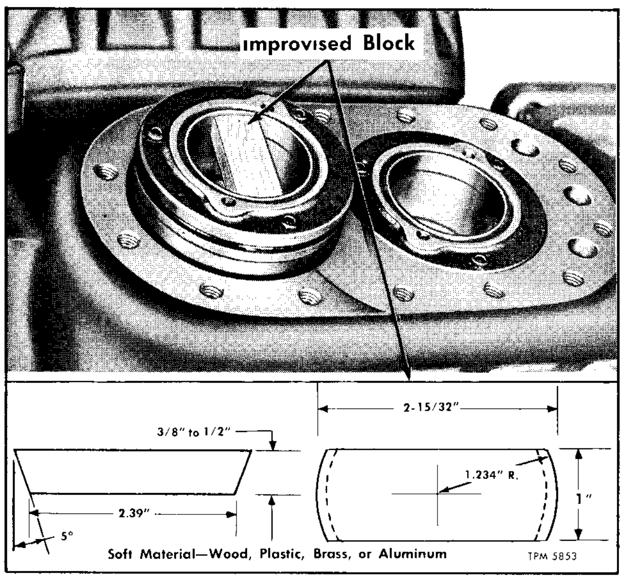


Figure 69—Using Improvised Block To Remove Suction Valve and Liner

HANDHOLE COVER REMOVAL AND DISASSEMBLY

NOTE: Key numbers in text refer to figure 65.

1. Handhole cover is identified by key number 15. Remove all but the top center cover attaching screw. The top center screw should be backed out approximately 8 to 10 turns, but should be left in the compressor housing to support the weight of the cover. If necessary, tap the cover with plastic hammer to free cover from compressor. Remove cover and cover gasket (16).

2. The opposite cover and gasket can be removed from compressor in same manner. There are no connections behind either cover to disconnect.

NOTE: The capacity control unit (20) is a complete assembly and can be removed with the handhole cover (fig. 68). Capacity control unit is not serviced and if it becomes inoperative, the entire cover with control must be replaced as a unit. Do not tamper with small nut and slotted screw on unit sensing lever. Slotted screw adjustment is factory set.

CYLINDER LINER, PISTON AND CONNECTING ROD REMOVAL

NOTE: The cylinder liner with or without unloader mechanism can be removed from compressor without having to remove the piston and connecting rod. See following Steps 1, 2, and 3.

NOTE: Key numbers in text refer to figure 65.

1. The suction valve plate (45) is tapered inward at the top. A block of wood, plastic, or soft metal should be improvised to dimensions shown in figure 69 to fit into this taper.

2. Rotate the crankshaft until piston head is down about 2 inches from top, then place the block into cylinder. Rotate crankshaft to cause piston (44) to press block and cylinder liner (48) from compressor bore (fig. 69). CAUTION: Do not bump piston against block, use an even pressure.

3. To remove liner only, make sure liner is forced out beyond the O-ring seal (33), then withdraw liner by hand. If liner is equipped with unloader, the unloader unit will come out with liner. Support the piston through the liner so that piston

does not bump against the compressor housing when the liner comes off piston.

IMPORTANT: Before removing other cylinder liner units the related piston and connecting rod should be removed from unit. Damage to the piston and piston rings will occur if crankshaft is rotated during removal of remaining liner units. See "Connecting Rod and Piston Removal and Disassembly" later in this section.

4. To remove liner, piston, and connecting rod as a complete assembly, rotate crankshaft (63) until connecting rod cap nuts (9) are accessible through the handhole cover openings. Remove nuts and flat washers (8) from cap bolts. Using soft driver rod and hammer, drive connecting rod bolts upward to free rod cap. Remove cap, then carefully pull liner with piston and rod from cylinder bore.

IMPORTANT: Keep all liner, piston, and rod assemblies separate and mark them in relation to bore from which they were removed.

5. If liner having unloader mechanism was removed, pull small oil connector (31) from hole in compressor cylinder bore or from bottom of unloader.

CYLINDER UNLOADER, CYLINDER LINER, AND SUCTION VALVE DISASSEMBLY

NOTE: Refer to Step 2 below for disassembly of liner assembly less the cylinder unloader mechanism. Key numbers in text refer to figure 65.

1. To remove unloader assembly (53) and unloader actuated parts from cylinder liner, grip the unloader firmly with both hands and strike bottom of liner against a soft wood (flat) surface (fig. 70). Separate unloader from liner. Invert piston on bench, then release retaining ring (32) and slide it off liner. Lift take-up ring (49) from liner and remove lift pins (5) and pin springs (4) from holes in liner.

NOTE: The unloader mechanism (53) is a subassembly which is not to be disassembled in the field. Should the unloader become inoperative, the entire unloader assembly must be replaced.

2. To disassemble liner and suction valve assembly only, remove three screws which attach valve plate (45) to top of liner. Be cautious not to move valve plate around top of liner as valve surfaces could be damaged. Carefully invert liner and valve assembly, keeping valve against liner. Lift liner (48) from valve plate (45). Remove suction valve (34), valve springs, and rubber O-ring seal (33) from valve plate.

NOTE: Until time of assembly keep valve plate with related liner as a matched set.

PISTON AND CONNECTING ROD DISASSEMBLY

NOTE: Key numbers in text refer to figure 65.

1. If rings (46 and 47) are to be reused, they

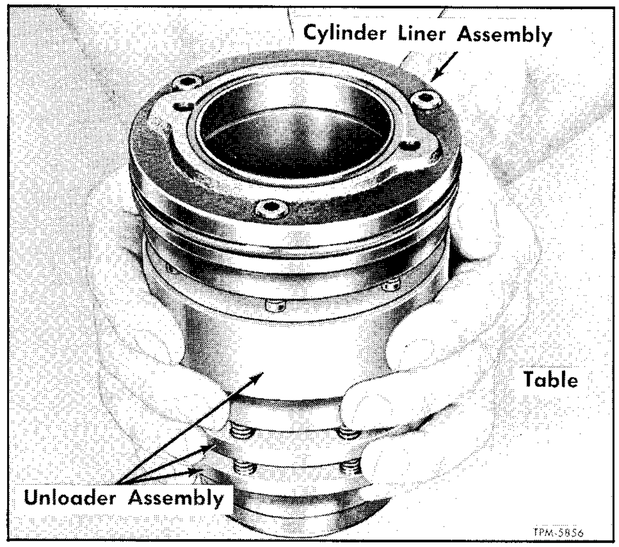


Figure 70—Method of Removing Unloader Assembly

can be removed from piston using thin shim stock inserted between rings and piston. Carefully work rings out of groove and slide them over the shim stock and off piston.

2. Using Tru-Arc pliers, remove snap rings (51) from ends of piston pin (52). Drive pin from piston using a soft driving rod. Use care not to nick piston surface or distort piston pin hole.

COMPRESSOR SHAFT SEAL REMOVAL

NOTE: Key numbers in text refer to figure 65.

1. Loosen and remove all but two opposite head cap screws (56) which attach seal cover plate (57) to front bearing head (60). Slowly and alternately back out the remaining two cap screws (fig. 71). Seal cover plate should be forced away from bearing head by tension of shaft seal spring. However, if plate does not follow the two cap screws,

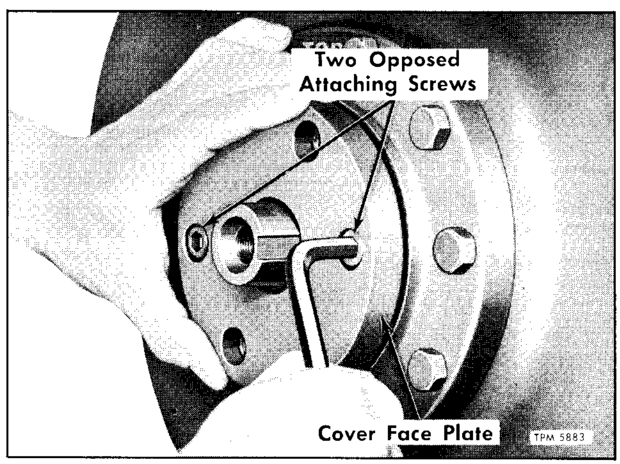


Figure 71—Removing Seal Cover Face Plate

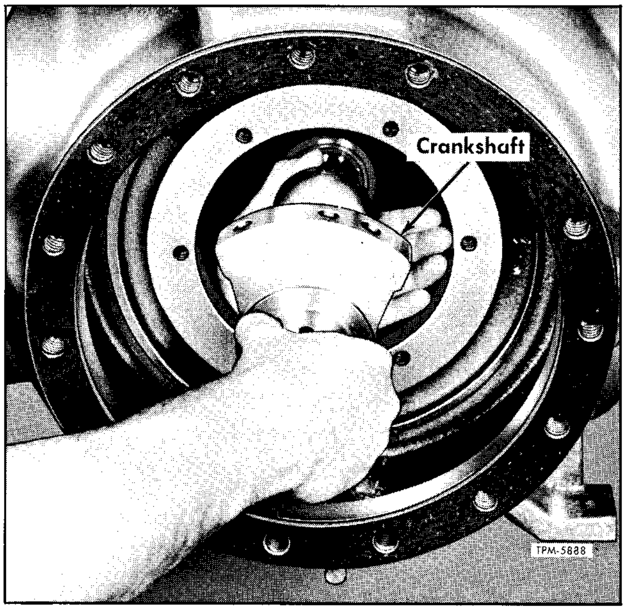


Figure 72—Recommended Method of Supporting Compressor Crankshaft When Making Replacement

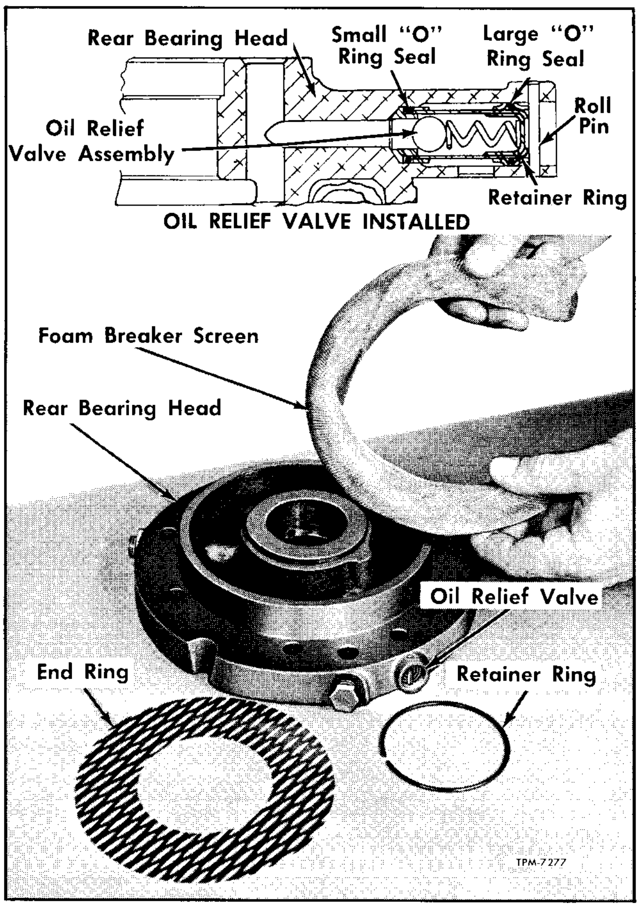


Figure 73—Foam Breaker Screen Removed and Oil Pressure Relief Valve Assembly Installed

tap rim of cover plate lightly with plastic hammer to free plate from housing. Carefully back out the two cap screws.

IMPORTANT: Be sure that plate is removed evenly so as not to distort seal and cause breakage of carbon ring within seal.

2. When the plate has been removed, the seal components (carbon nose ring, neoprene ring, steel retainer, spring, and spring holder) can usually be pulled from crankshaft. In some cases, the neoprene ring will adhere to shaft. It can be loosened by using a seal puller or by hooking short ends of two Allen-type wrenches behind ring and pulling ring from shaft.

IMPORTANT: Use extreme care in the handling and stowing of seal components. The carbon nose ring can be easily broken.

SUCTION COVER AND STRAINER PAN REMOVAL

NOTE: Key numbers in text refer to figure 65.

1. Remove all suction cover attaching screws (25) with the exception of the top screw. Back out top screw 10 or 12 full turns. This screw will support cover when cover seal is broken.

2. The cover is provided with two jack screw holes. Thread two cover attaching screws in these holes, then turn screws alternately to force cover from compressor housing. Remove cover and cover O-ring (26).

3. Remove strainer pan assembly (27) from the compressor suction chamber. Strainer assembly can be serviced as explained later under "Cleaning and Inspection."

OIL PUMP REMOVAL

NOTE: Key numbers in text refer to figure 65.

Remove four socket head screws which attach oil pump assembly (66) to rear bearing head (71). Remove oil pump and pump gasket (73). NOTE: It may be necessary to rock pump assembly up and down to break the gasket seal. CAUTION: Do not strike pump with hammer.

BEARING HEADS AND CRANKSHAFT REMOVAL

NOTE: Crankshaft is removed from rear (suction end) of compressor. Key numbers in text refer to figure 65.

1. Remove screws which attach rear bearing head (71) to compressor housing. Insert two attaching screws into jack screw holes in bearing head. While turning screws inward to pull bearing head, check to see if crankshaft, which might be seized to bearing, is following bearing head. If it is, support front end of shaft through handhole cover opening. If shaft does not follow head, back head out and support at bottom with hand. Remove head or head and crankshaft. Remove shims (29) from head or housing.

2. If crankshaft was not removed with rear bearing head, grip crankshaft at center and at rear end, then slowly and carefully draw shaft out of compressor (fig. 72).

IMPORTANT: Do not damage bearing surface in front bearing head while removing shaft.

3. Remove magnetic plugs (55) from crankshaft and remove metallic particles from magnets.

4. Remove screws attaching front bearing head (60) to compressor housing. Use two screws as jack screws in tapped holes in bearing head. Remove head and head O-ring (61).

REAR BEARING HEAD DISASSEMBLY

NOTE: Key numbers in text refer to figure 65.

1. Remove retaining ring (67) which secures end ring (68) over foam breaker screen (70).

2. Lift foam-breaker screen (70) from recess in head. Screen should be cleaned as directed later under "Cleaning and Inspection." Figure 73 illustrates screen and retaining parts removed from head cavity.

3. If necessary, plugs can be removed from bearing head. Remove metallic particles from the magnetic plug.

4. Referring to sectional view of figure 73, remove relief valve assembly from bearing head by driving the small retaining pin from over valve. then using a pointed tool through hole in side of head, pry valve from head. Clean and inspect valve components.

5. Remove three check valve assemblies (23) from rear bearing head. Inspect valves for plugged condition.

CRANKCASE OIL STRAINER AND CHECK VALVE REMOVAL

NOTE: Key numbers in text refer to figure 65.

1. Loosen, but do not disconnect, flare nut at tube end of strainer assembly (64).

2. Disengage one end of strainer hold-down retainer (21) from housing, then disengage opposite end. Remove retainer.

3. Disconnect strainer tube flare nut, then remove strainer from housing through handhole cover opening.

4. Remove oil check valve (69) from housing and remove check valve (7) protruding down from top of compressor housing.

SUCTION AND DISCHARGE VALVES REMOVAL

Remove two bolts which attach each valve body to compressor housing. Lift valve assembly from housing, then remove valve body gasket. Line flange clamp and flange seal can be removed from valve body after removing four flange clamp bolts. Figure 62 shows cross section of valve assemblies.

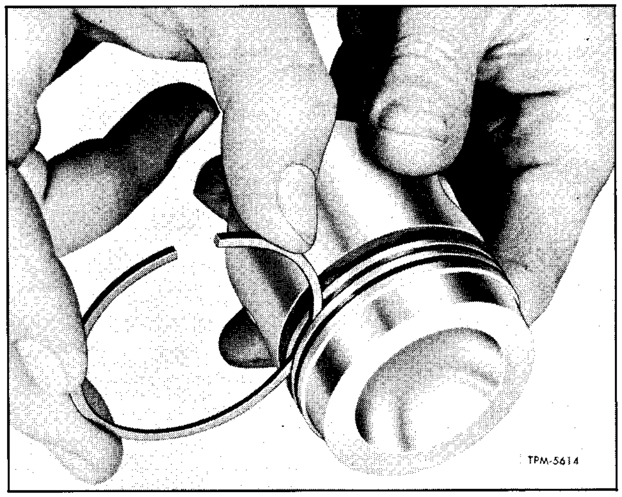


Figure 74—Checking Piston Ring Groove Clearance

CLEANING AND INSPECTION

CLEANING

1. Clean all compressor components except the oil filter element (72, fig. 65) at bottom of oil strainer pan with refrigeration compressor parts cleaner. DO NOT USE CARBON TETRACHLORIDE. The oil filter element, if contaminated, should be replaced. Use a stiff bristle brush if necessary to loosen foreign particles. Direct air through all

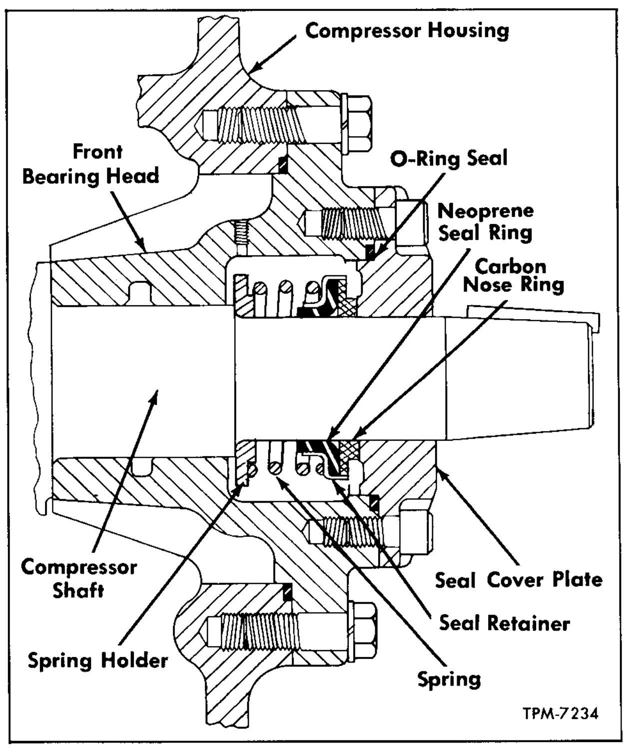


Figure 75—Crankshaft Seal Construction

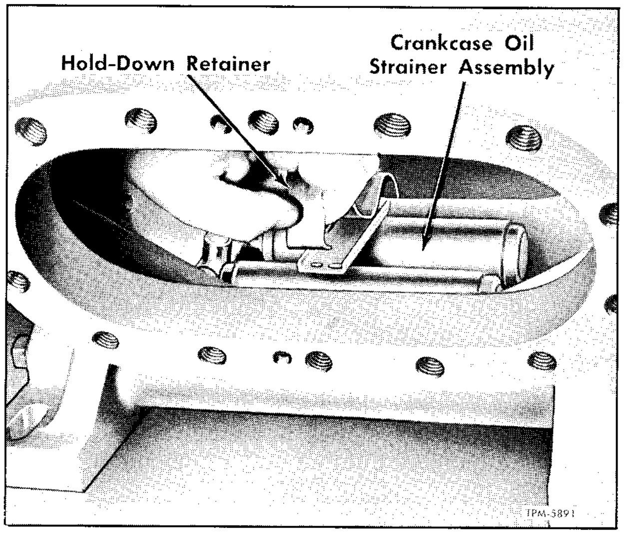


Figure 76—Installing Crankcase Oil Strainer Hold-Down Retainer

passages in castings and into both ends of all check and relief valves. If necessary, valves can be disassembled, cleaned, and inspected. If balls fail to seat properly in valve bodies, replace entire valve assembly.

2. Scrape all gasket flange surfaces to make sure all gasket and sealing material is removed.

CAUTION

DO NOT GOUGE FLANGE SURFACE WHILE SCRAPING.

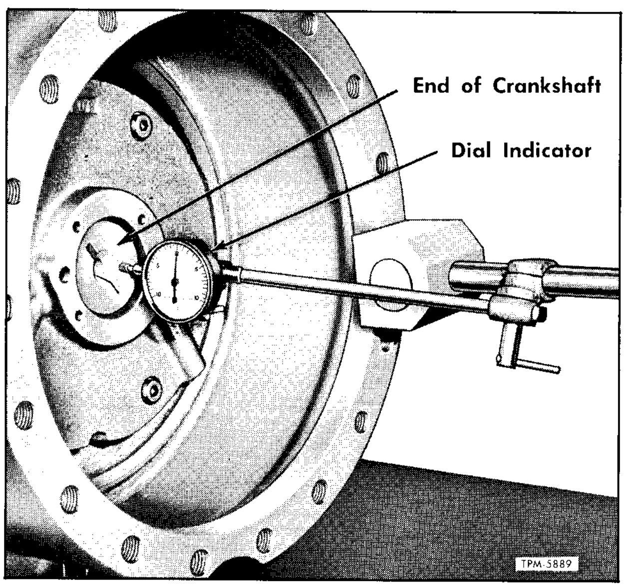


Figure 77—Checking Crankshaft End Play Using Dial Indicator

INSPECTION

NOTE: Key numbers in text refer to figure 65.

1. Inspect compressor housing (62) and other tapped components for cross threads and any other damage.

2. Examine valve surfaces of suction and discharge valve components. Try blowing air through valve ports while in open and closed positions to check for sealing. Replace worn parts.

3. Inspect pistons (44) for scoring, cracks, or damage of any kind.

4. Check fit of rings (46 and 47) in piston ring grooves. Use back edge of ring to check fit (fig. 74). Rings should move freely in piston grooves.

5. Examine crankshaft seal components for excessive wear or damage. If components are found in good condition they can be reused. If damaged, replace with complete new seal assembly. Figure 75 shows seal components installed. Check components of compressor for wear to dimensions shown on "Compressor Wear Rate Table" at rear of this section under "Specifications."

COMPRESSOR BUILD-UP

Before building up compressor, coat all components with clean compressor oil. This will provide initial lubrication and prevent rusting.

Use new O-ring seals and gaskets when assembling compressor.

NOTE: Key numbers in following text refer to figure 65.

SUCTION AND DISCHARGE VALVE INSTALLATION

1. Using new gasket, attach valve body to compressor housing with two bolts. Tighten bolts evenly and firmly.

2. If line flange clamp was removed, place new seal gasket in position, then install line and clamp flange to valve body with four bolts. Tighten bolts evenly to 58 foot-pounds torque.

CRANKCASE OIL STRAINER AND CHECK VALVE INSTALLATION

NOTE: Key numbers in text refer to figure 65.

1. Install two check valves (7) into roof of compressor housing.

2. Install oil check valve (69) in housing at lower rear end.

NOTE: Identification of valves can be made by the amount of distance ball travels in valve body. Valve with long ball travel should be installed into roof of crankcase, valve with short travel should be installed at rear of housing (see fig. 65).

3. Place strainer assembly (64) into compressor housing and connect strainer tube flare nut loosely. Secure strainer to bottom of housing with hold-down retainer (21). Make sure ends of retainer

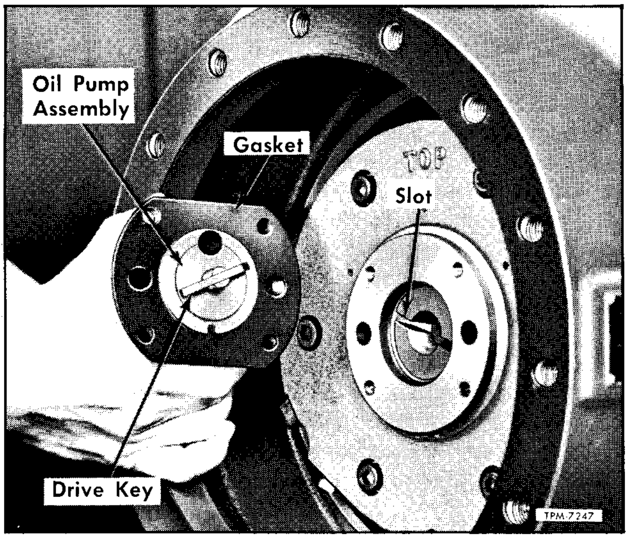


Figure 78—Installing Compressor Oil Pump

engage holes in housing (fig. 76). Final tighten strainer flare nut.

ASSEMBLY OF REAR BEARING HEAD

NOTE: Key numbers in text refer to figure 65.

1. Install check valves (23) into rear bearing head.

2. With O-ring seals in relief valve grooves, install relief valve assembly with retainer ring as shown in sectional view of figure 73, into bearing head. Secure valve in position with pin driven into holes over valve.

3. If hex plugs were removed from bearing head, install plugs, making sure they are tightened firmly.

4. Roll foam-breaker screen (70) into shape and place in bearing head cavity. Place end ring (68) over screen, then install retaining ring (67). Make certain retaining ring is fully seated in ring groove.

BEARING HEADS AND CRANKSHAFT INSTALLATION

NOTE: Key numbers in text refer to figure 65.

1. Install two magnetic plugs (55) into crankshaft oil passages.

2. Lubricate all bearing surfaces of crankshaft and bearing surfaces in bearing heads. Install front bearing head. Make sure "Top" marked on front bearing head is properly located, then attach front bearing head to compressor housing with cap screws. Do not final tighten cap screws until after rear bearing head is installed later.

3. Carefully insert crankshaft into compressor housing. Balance crankshaft with one hand through handhole opening (fig. 72), then carefully insert crankshaft through front bearing.

CAUTION: Do not damage bearing surfaces.

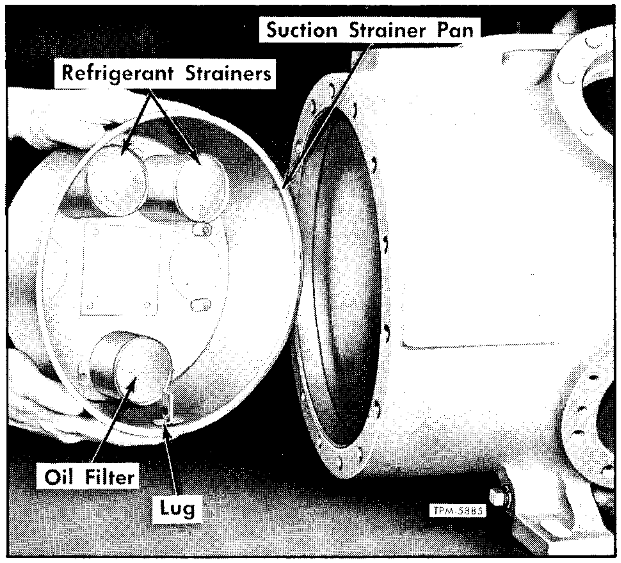


Figure 79—Installing Suction Strainer Pan

Weight of crankshaft now is supported safely by front bearing head.

4. Before installing rear bearing head (71), three (0.015" thick) paper shims (29) should be placed on flange on rear bearing. Shims serve to provide proper crankshaft end play clearance. NOTE: Two thicknesses of shims are available, 0.910" and 0.015", and they should be installed dry.

5. With shims in place, carefully position rear bearing head (71) on rear end of crankshaft. Make sure "TOP" marked on head is properly located. Install head attaching bolts, then tighten both front and rear head attaching bolts evenly to 30 foot-pounds torque.

6. Check crankshaft end play, using a feeler gauge between crankshaft and rear bearing head. Check clearance in several places around the shaft. Push crankshaft forward while checking end play. The proper end play clearance should be 0.010" to 0.017". If clearance is above maximum, decrease thickness of shims (29). If clearance is be-

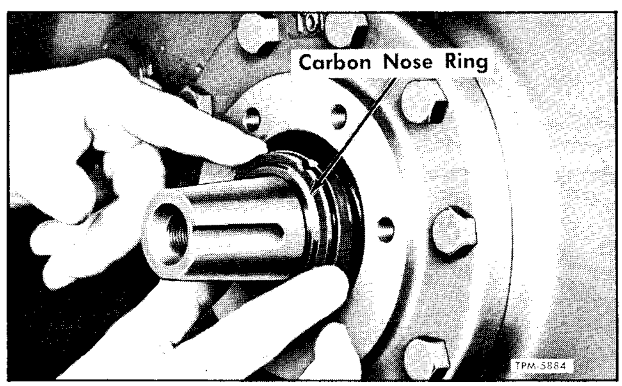


Figure 80—Installing Seal Carbon Nose Ring

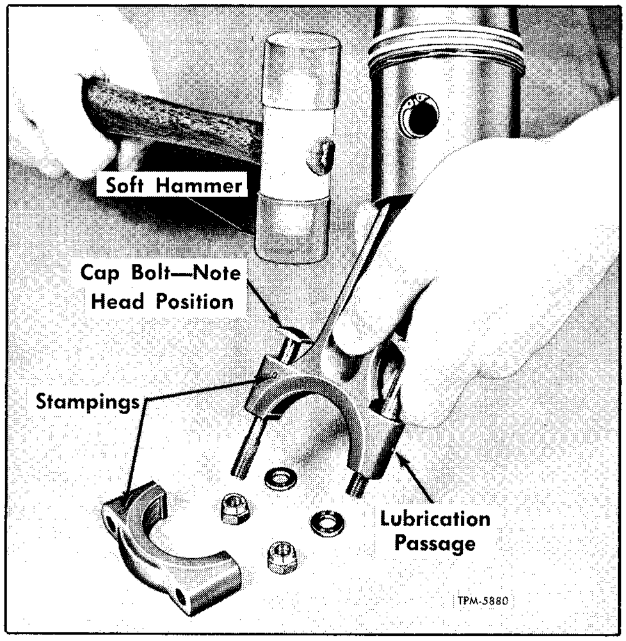


Figure 81—Installing Connecting Rod Cap Bolt

low minimum allowance, increase shim thickness. A combination of shims should be selected to obtain proper end play clearance. An alternate method of checking crankshaft end play is to use a dial indicator as shown in figure 77. Move crankshaft fore and aft while using this method. Make sure dial is mounted firmly.

7. After final adjustment is obtained, torque front bearing head attaching bolts to 30 foot-pounds torque and rear bearing head bolts to 23 foot-pounds torque.

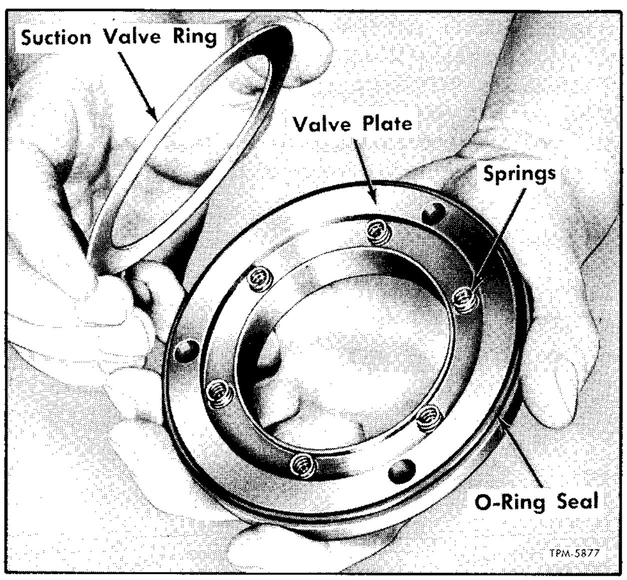


Figure 82—Assembling Suction Valve

OIL PUMP INSTALLATION

1. Before installing oil pump (66), make sure pump flange and bearing head surfaces are clean.

2. Insert attaching bolts with lock washers through pump assembly. Lubricate pump gasket (73) with clean compressor oil, then position gasket over threaded ends of bolts.

3. Align key of pump shaft with slot in end of crankshaft (fig. 78), then install pump to bearing head. Tighten pump attaching bolts to 14 foot-pounds torque.

SUCTION STRAINER AND
COVER INSTALLATION

NOTE: Key numbers in text refer to figure 65.

1. If suction strainer screens (28) or oil filter assembly (72) were removed from the strainer pan, attach these units to pan firmly with screws and lock washers. Units are located on pan as shown in figure 79.

2. Place strainer pan assembly into suction chamber, making sure slot in bottom of rear bearing head is engaged with guide on pan.

3. Lubricate cover gasket (26) with clean compressor oil, then position gasket to cover.

4. Place two attaching bolts (25) with flat washers into suction cover (one at top and one at bottom), then install cover to compressor. Make sure name on cover is positioned properly. Tighten two bolts finger-tight, then install remaining attaching bolts and washers. Tighten all bolts evenly to 58 foot-pounds torque.

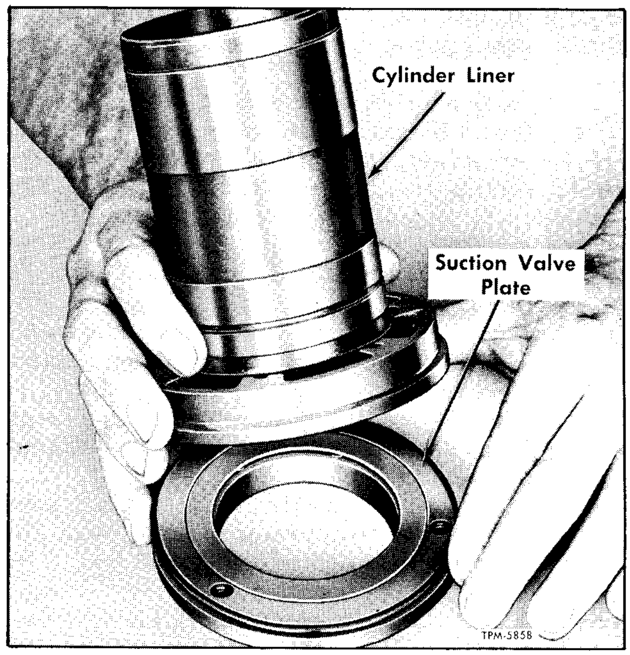


Figure 83—Locating Cylinder Liner on Suction Valve

COMPRESSOR SHAFT SEAL INSTALLATION

NOTE: Refer to figure 75 when assembling seal kit.

1. Seal components must be installed as a kit. Never attempt to replace any of the single components of seal assembly. Seal kit consists of carbon nose ring, neoprene ring, spring retainer, spring, spring holder and seal cover plate as shown.

2. With finger, check shaft seal surface. Surface should be smooth and free of dirt.

3. Apply clean compressor oil or white petroleum jelly to inner surface of Neoprene ring and to shaft.

IMPORTANT: After shaft is lubricated do not touch it again with fingers.

4. Position spring to spring holder, then install both over shaft and into seal chamber.

5. Install steel retainer and Neoprene ring over shaft, using care not to damage ring on sharp edges of shaft keyway slot.

6. Thoroughly clean carbon nose ring with cleaning fluid, then inspect ring for grooved, cracked, or chipped condition. Once ring has been cleaned do not touch again with fingers.

7. Wet face of nose ring with clean compressor oil, then place ring over shaft end and into engagement with notches of Neoprene ring retainer (fig. 80).

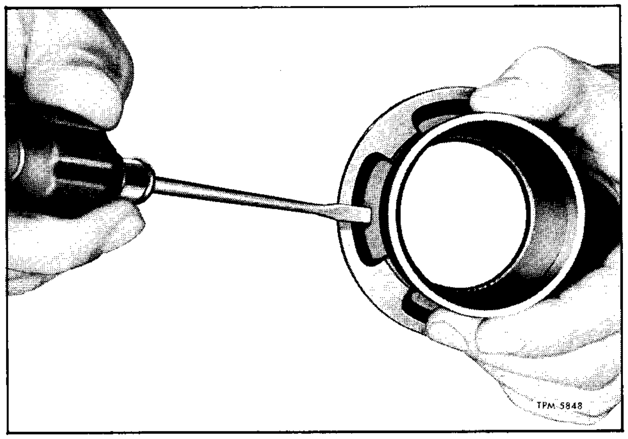


Figure 84—Checking Suction Valve Alignment

8. Clean and lubricate sealing surface of seal cover plate. Lubricate O-ring seal, then position seal around flange of cover plate.

9. Insert two attaching screws into opposite holes of cover plate. Carefully press plate assembly evenly against carbon ring and to compressor. Tighten both attaching screws slowly and alternately one or two threads at a time (fig. 71), otherwise carbon nose ring may crack.

10. When seal cover plate is flush to housing

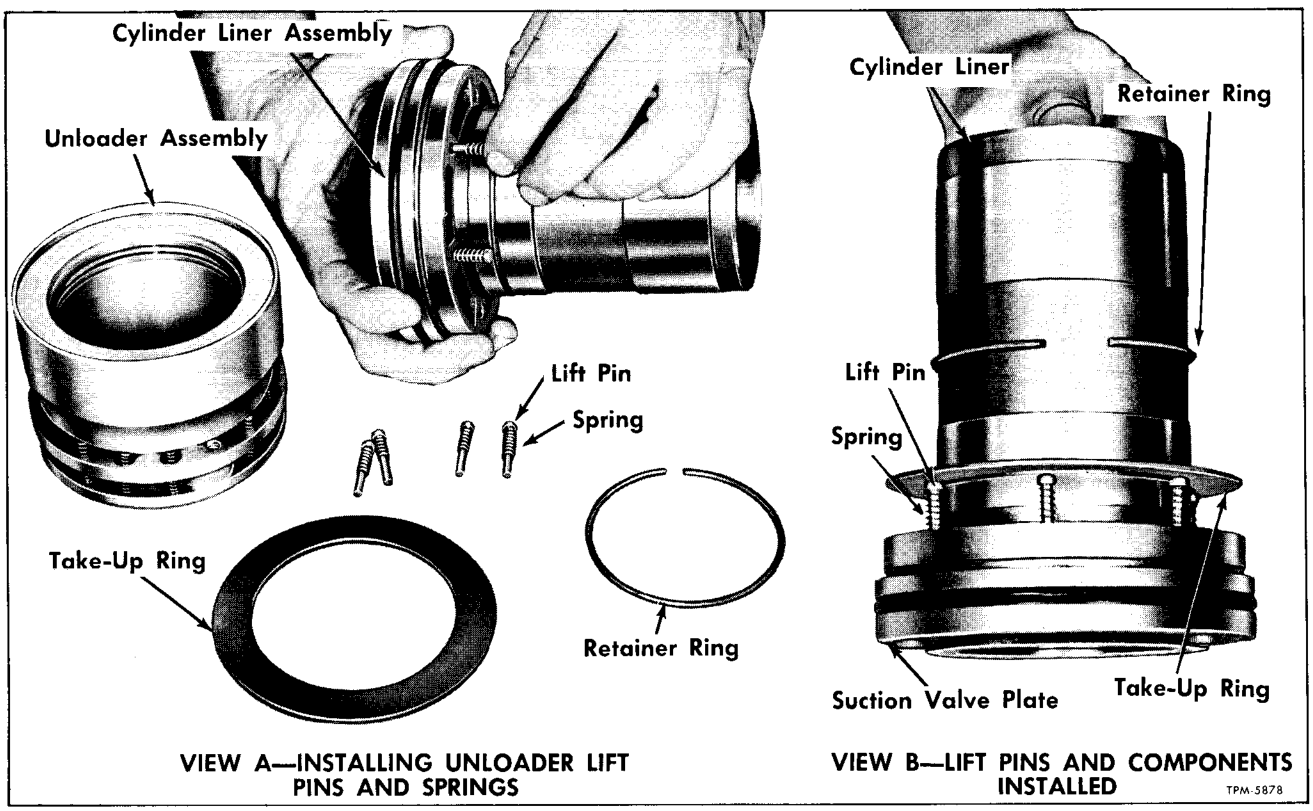


Figure 85—Building Up Unloader Components

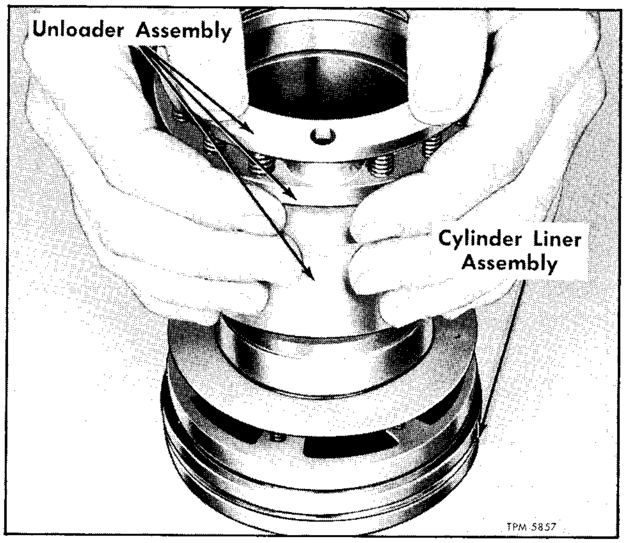


Figure 86—Installing Unloader Assembly

install remaining attaching screws. Tighten all screws to 23 foot-pounds torque.

ASSEMBLY OF PISTON, RINGS, AND CONNECTING ROD

NOTE: Key numbers in text refer to figure 65.

1. Position connecting rod (54) in piston (44). Drive piston pin (52) through piston and rod using a hammer and soft driver. Install pin snap rings (51) using Tru-Arc pliers.

2. Work rings (46 and 47) carefully over top of piston to their respective grooves, using shim stock to aid in moving rings into position. NOTE: Oil ring (47) goes in bottom groove and the two compression rings (46) go in two upper grooves. Check for freeness of rings in grooves after installing.

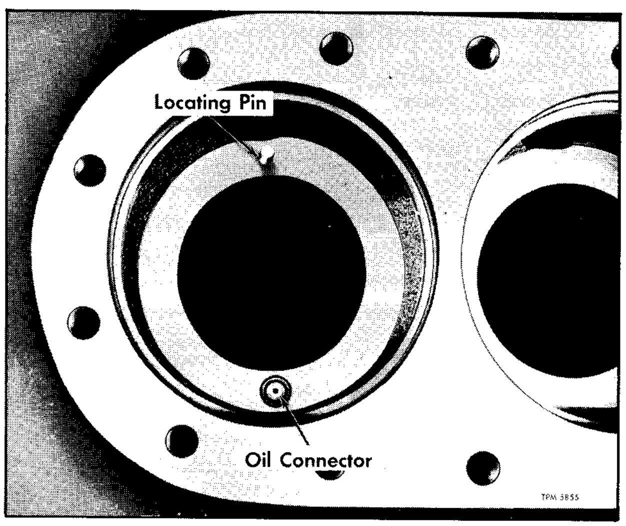


Figure 87—Alignment Pin and Oil Connector Installed

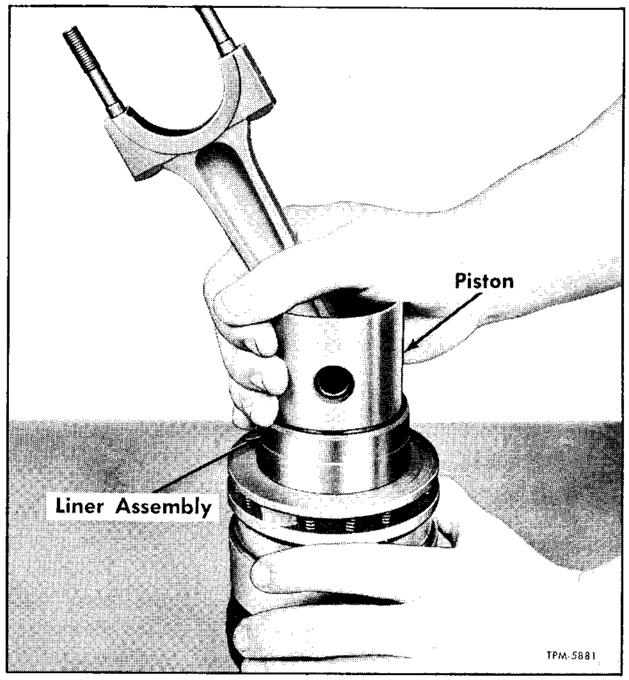


Figure 88—Installing Piston in Liner Assembly

3. Inasmuch as connecting rod bolts (10) are a tight fit in connecting rod, they must be driven into place with a light weight soft hammer (fig. 81). Be sure that flat side of bolt head is positioned to mate with shank on rod.

ASSEMBLY OF SUCTION VALVE, LINER, AND UNLOADER MECHANISM

NOTE: Key numbers in text refer to figure 65.

1. Install O-ring seal (33) around flange of suction valve plate (45).

2. Insert six springs into pockets of suction valve plate (fig. 82), then place suction valve ring (34) over springs.

3. Locate cylinder liner (48) on valve plate (fig. 83), then invert both liner and plate and set in upright position on bench. Install three socket head screws attaching plate to liner. Tighten screws snug only. Again invert liner and plate and with small screwdriver check suction valve ring to see that its movement is not restricted (fig. 84). Tighten plate attaching screws to 7 foot-pounds torque.

4. On liners having unloaders, position springs (4) on lift pins (5), then insert pins into flange of liner (View A, fig. 85). NOTE: Push pins in and out to see that movement is free. Lower the take-up ring (49) down over heads of pins, then install retainer ring (32) over take-up ring (View B, fig. 85) to position in ring groove. Check action of take-up mechanism by pressing up and down on take-up ring.

5. The cylinder unloader, when used, slides down over cylinder liner and is sealed in position

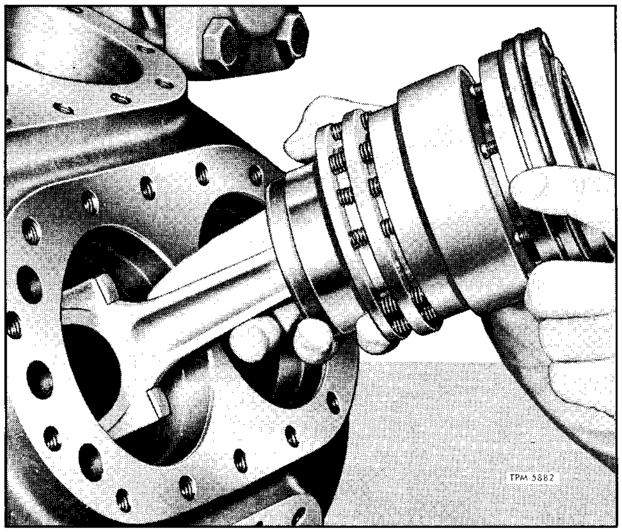


Figure 89—Installing Connecting Rod, Piston Liner, and Unloader Assembly

by two O-ring seals (50). Oil external surfaces of cylinder liner and inside diameter of unloader with clean compressor oil. Referring to figure 86, position liner as shown on a clean flat surface, then press unloader mechanism slowly and evenly down over liner.

CAUTION

Keep fingers free of being pinched between unloader and liner flange.

When the unloader mechanism is in final position, it should be touching the surface of take-up ring (49). Be sure retainer ring (32) is properly in place in groove in cylinder liner so that unloader mechanism and take-up ring will operate correctly.

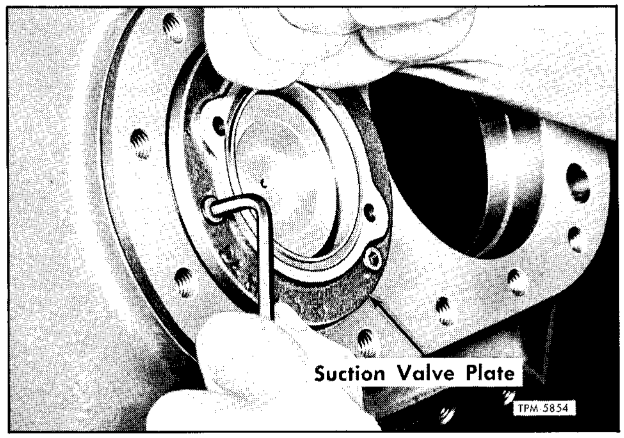


Figure 90—Method of Aligning Suction Plate

INSTALLATION OF CONNECTING ROD, PISTON, AND CYLINDER LINER

NOTE: The installation of cylinder liner with unloader is the same as the installation of the plain liner less unloader as far as entry of piston and rings are concerned. The main difference, however, is in the proper positioning of unloader in the compressor housing. The unloader cylinder housing is fitted with a roll-pin and an oil connector as shown in figure 87. The inside of unloader has two holes which must coincide with roll pin and oil connector.

NOTE: Key numbers in following text refer to figure 65.

1. Invert cylinder liner on clean flat work surface. Rotate piston rings on piston to stagger the ring gaps. Apply clean compressor oil to rings and to inner walls of liner.

2. Carefully insert piston down into liner (fig. 88). NOTE: Both piston and liner are tapered to assist installation. Rotate and rock piston while at

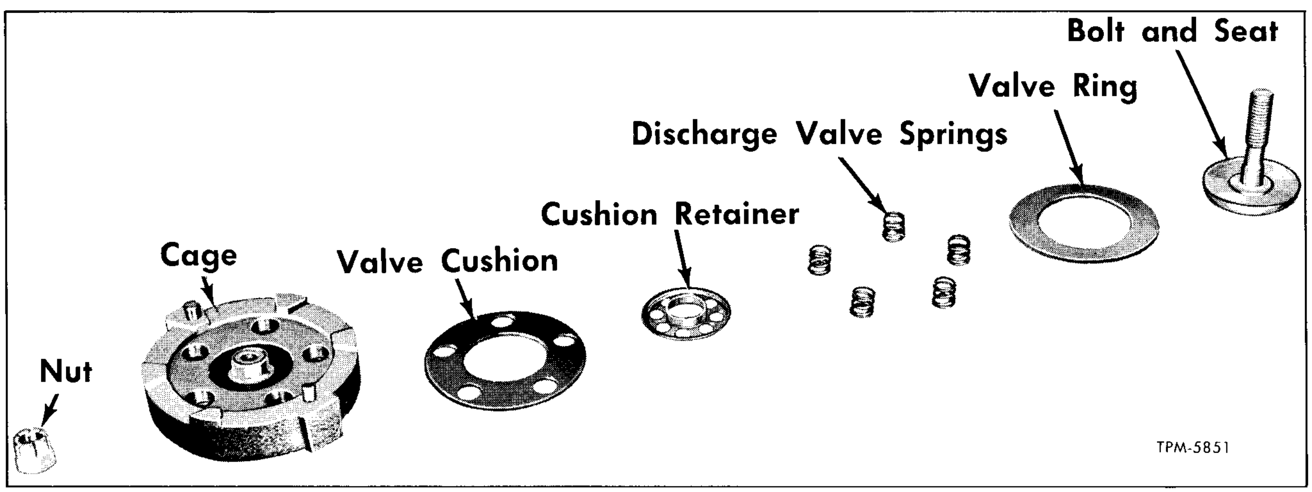
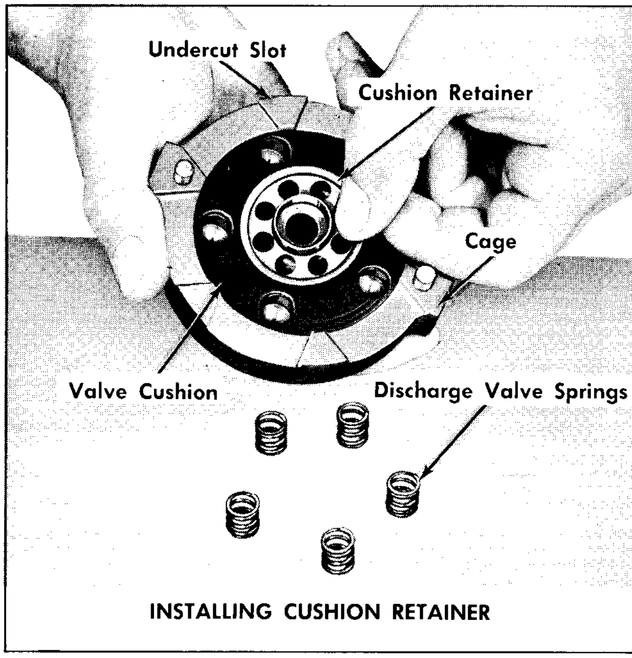


Figure 91—Discharge Valve Components



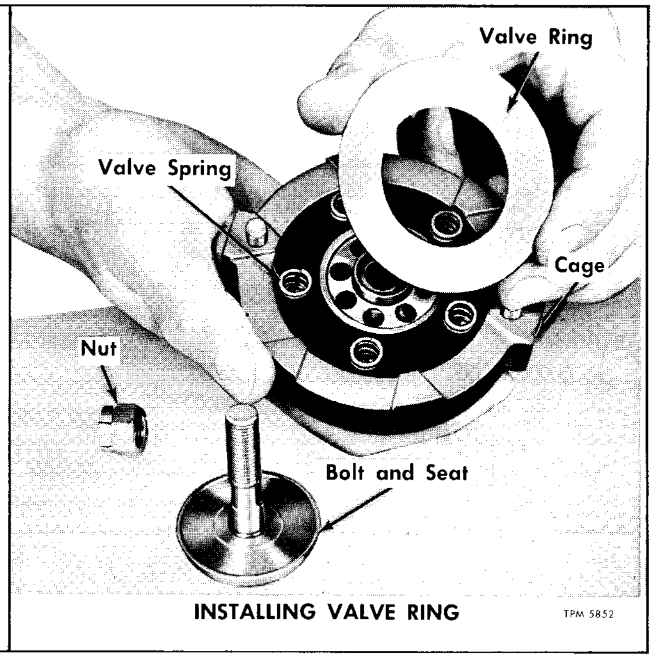


Figure 92—Building Up Discharge Valve Assembly

same time pressing lightly downward causing rings to compress into liner. Press piston into liner until the bottom of piston is flush with bottom of liner.

3. IMPORTANT: Before installing connecting rod with liner assembled, make sure bearing surfaces on crankshaft and connecting rod are clean and free of dirt. Lubricate these surfaces with clean compressor oil.

4. In housing bore where a liner having unloader mechanism is to be installed, insert oil connector (31), with two new O-ring seals (30) in each end of connector, into lower hole (fig. 87). Before installing connector apply clean compressor oil to O-ring seals.

5. Rotate the crankshaft until shaft journal is in position to accept connecting rod.

6. Rotate the liner with reference to connecting rod so that side of rod with match marks (see figure 81 for match mark locations) are facing the seal end of compressor and the alignment pin and oil connector holes (fig. 87) are properly aligned for entry into housing liner bore.

7. All connecting rods have corresponding match marks (fig. 81) which identify the rod and cap as being matched. IMPORTANT: These two matched parts must be assembled so that they are on the same side of rod and when assembling the rod to crankshaft, the marks must always be positioned facing the seal end of compressor.

8. Referring to figure 89, push the entire connecting rod and liner assembly down into housing bore as far as liner will go without being forced.

9. With connecting rod in position at crankshaft journal, install rod cap (65). CAUTION: Make sure match marks on rod and cap correspond and that both are facing seal end (drive end) of compressor.

The rod cap must be drawn evenly into final position by the rod bolt nuts and washers, otherwise cap will become distorted and damaged. Tighten nuts snug only at this time.

10. Using hands, push cylinder liner down into housing bore. CAUTION: NEVER ATTEMPT TO SEAT LINER USING A HAMMER.

If liner will not seat, and alignment pin and oil connector on units having unloaders are in alignment, loosen the three screws which attach suction valve plate to liner. Referring to figure 90 push liner into bore as shown. When liner is in place, tighten socket head cap screws.

NOTE: Rotate unloader mechanism if necessary to align with alignment pin and oil connector in housing bore. If an attempt was made to force unloader mechanism down when improperly positioned, the small O-ring seal (30) on oil connector may have been damaged. A damaged seal may cause erratic functioning of the unloader mechanism when compressor is operated. Replace seals if damaged.

11. After liner is properly seated into compressor housing, final tighten connecting rod nuts to 15 foot-pounds torque.

CAUTION: Use a torque wrench and under no circumstance should nuts be tightened above specified torque, as cap will be distorted. Rotate the crankshaft to make sure that connecting rod is free on shaft. Repeat as each rod is installed.

HANDHOLE COVER INSTALLATION

NOTE: Key numbers in text refer to figure 65.

1. Before installing handhole cover (15), make sure cover is clean.

2. Oil both sides of cover gasket (19) with clean compressor oil, then position gasket to cover flange. Insert two cover attaching bolts up through cover and gasket (one at each end of cover).

3. Position cover and gasket to compressor housing and tighten the two bolts hand-tight. Install remaining bolts, then final tighten all bolts evenly to 43 foot-pounds torque.

ASSEMBLY OF DISCHARGE VALVE COMPONENTS

NOTE: Key numbers in text refer to figure 65. Figure 91 illustrates components of valve assembly.

1. Place valve cushion (37) into discharge valve cage (40), making sure that outer edge of cushion is tucked into undercut slot in cage. Align holes in cushion with spring pockets in cage.

2. Press valve cushion retainer (41) into place (left view, fig. 92), then position discharge valve springs through cushion and into cage spring pockets.

3. Lay discharge valve ring (36) over springs as shown in right view, figure 92. Insert seat (43) and bolt (39) into cage, then install bolt nut (38). Before tightening nut, make sure discharge valve ring (36) registers in the valve guide. Tighten nut to 23 foot-pounds torque, then check valve ring movement for any restriction by the valve guide. Ring must be free.

DISCHARGE VALVE AND CYLINDER HEAD INSTALLATION

NOTE: Key numbers in text refer to figure 65.

1. Position discharge valve assembly to cylinder liner with valve cage dowels located in liner holes (fig. 67).

2. Place safety head springs (3) over discharge valves, making sure they are centered over valves (fig. 67).

3. Insert two attaching bolts with washers through cylinder head (2), one at each end (fig. 66). Apply clean compressor oil to both sides of head gasket (1), then position gasket and head to compressor housing. Tighten two bolts alternately. Install remaining attaching bolts, then tighten all bolts to 43 foot-pounds torque.

4. If compressor is to be placed in storage, the suction and discharge valves should be closed (stems turned clockwise) and the line ports should be plugged.

COMPRESSOR DRIVE

Compressor, mounted in coach as shown in figure 93 is driven through an air-operated disc clutch which is mounted to drive end of compressor. Clutch is propeller shaft driven from accessory drive unit mounted to front end of coach engine.

The condenser fan drive pump is belt-driven through the compressor drive clutch from the compressor flywheel pulley.

Clutch is engaged by air pressure admitted through an electrically-operated air valve (26, fig. 7). Air pressure from solenoid valve to the clutch is supplied through a flexible air line.

When air pressure is applied to clutch cylinder the clutch is engaged. When air pressure is exhausted from cylinder clutch becomes disengaged. Spring within clutch removes the pressure from clutch plate.

Procedures for removing and overhauling the clutch assembly are explained later under "Compressor Drive Clutch." Overhaul procedures of clutch assembly is also explained later under "Compressor Drive Clutch."

COMPRESSOR DRIVE OPERATION

With "VENTILATION" switch on control panel at left of driver placed in "AIR CONDITION" position, and with the engine oil pressure being less than 15 psi and the pressure in coach air system at 65 psi or more, the clutch control solenoid valve becomes energized. With solenoid valve operating coil energized, air pressure is admitted to clutch air cylinder through the flexible line which releases

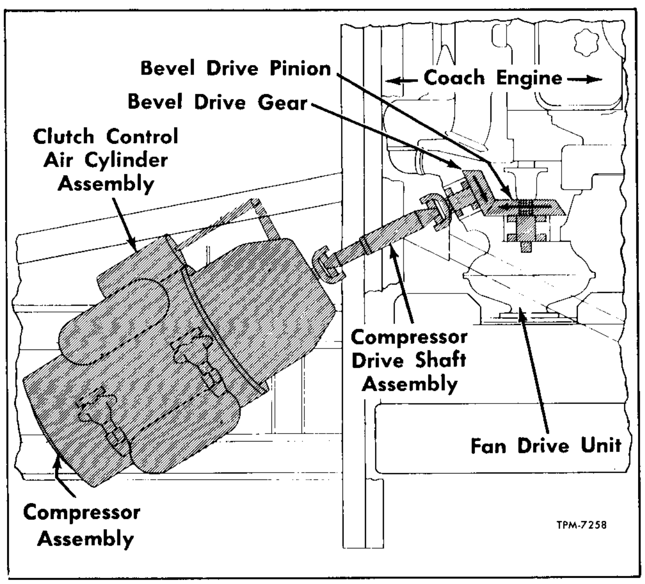


Figure 93—Compressor Drive Shaft and Accessory Drive Layout (Typical)

SYSTEM MAINTENANCE

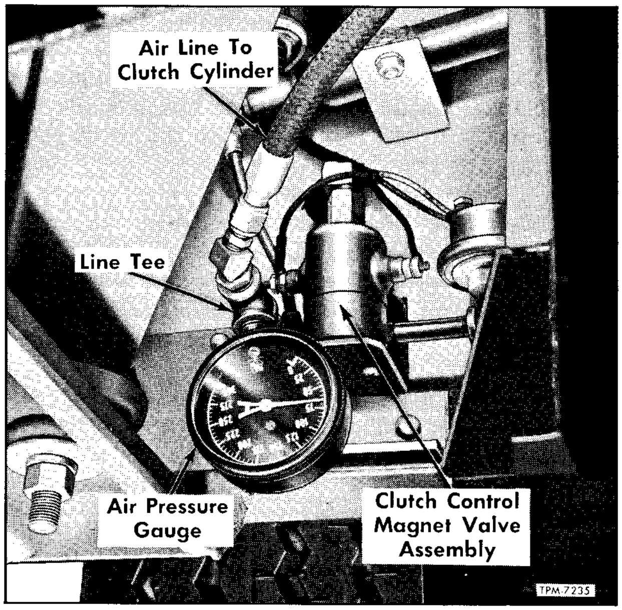


Figure 94—Clutch Control Air Pressure Check (Typical)

pressure from clutch cover spring causing clutch to become engaged. Lower view of figure 95 shows clutch in the engaged position, air pressure applied. The upper view of figure 95 shows disassembled components of clutch.

Refer to Schematic Wiring Diagram (fig. 3) for electric circuits. Detail wiring diagram is shown in back of this manual.

COMPRESSOR DRIVE MAINTENANCE

The following instructions apply to items which require periodic inspection and adjustment. Maintenance information on compressor drive propeller shaft, accessory drive clutch, and clutch control air cylinder is explained later under respective headings.

Inspect clutch drive components, making sure clutch housing bolts and drive shaft universal joint flange bolts and nuts are tight.

CLUTCH CONTROL AIR PRESSURE CHECK

In manner shown in figure 94, check the air pressure to clutch control cylinder. Disconnect air line between solenoid valve and air cylinder, and install a test air pressure gauge as shown. Deplete pressure in coach air system down to 40 to 50 pounds or even less. While observing test gauge have assistant start engine and place air conditioning control to operating position. Note pressure on gauge at time solenoid valve releases air pressure to test gauge. Solenoid valve should be energized (opened) by the air pressure switch at 65 $\pm$ 3 pounds. If this does not occur, replace air pressure switch (fig. 94), then recheck.

LUBRICATION

After each three months of operation, two small square head plugs should be removed from end covers of clutch control air cylinder and 1/2 oz. of SAE 10W engine oil injected into cylinder. Replace plugs firmly after adding lubricant.

At regular chassis lubrication intervals, apply SAE #140 gear lubricant to fitting at each joint of compressor drive shaft assembly and also to fitting on shaft slip yoke.

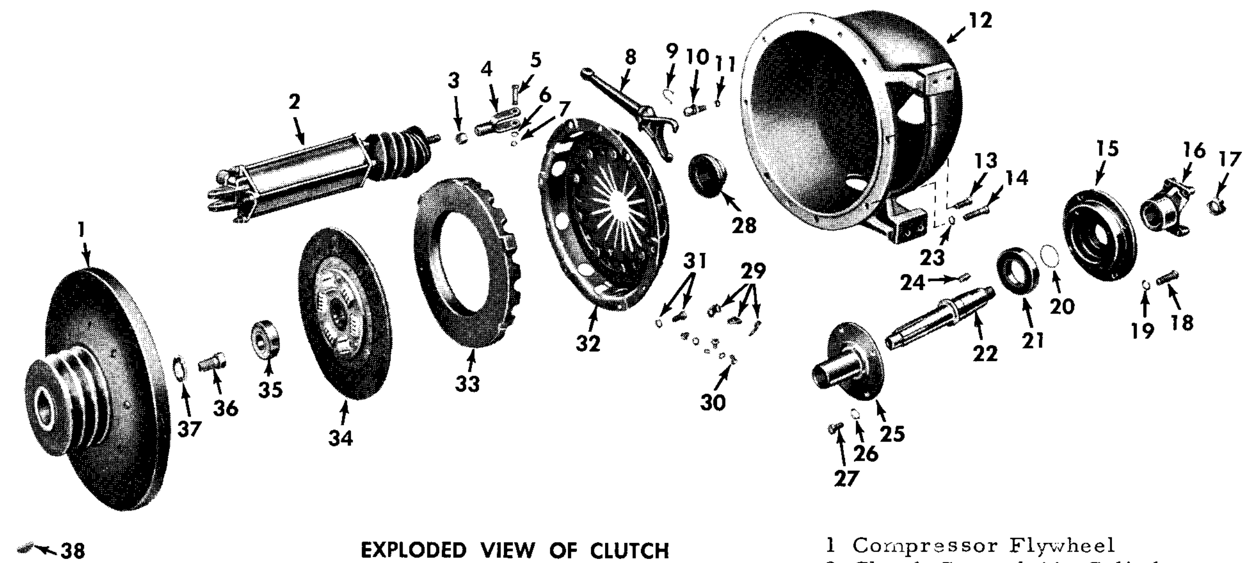
Before placing system in season operation and at periodic chassis lubrication intervals, the clutch release bearing retainer, item 25, figure 95 and the pin at each end of clutch air cylinder should be lubricated. Access to the bearing retainer can be obtained by removing the compressor compartment dust shield and using a small long-handled brush to reach into access hole in underside of clutch housing. Use grease containing zinc oxide.

COMPRESSOR CLUTCH RELEASE FORK ADJUSTMENT

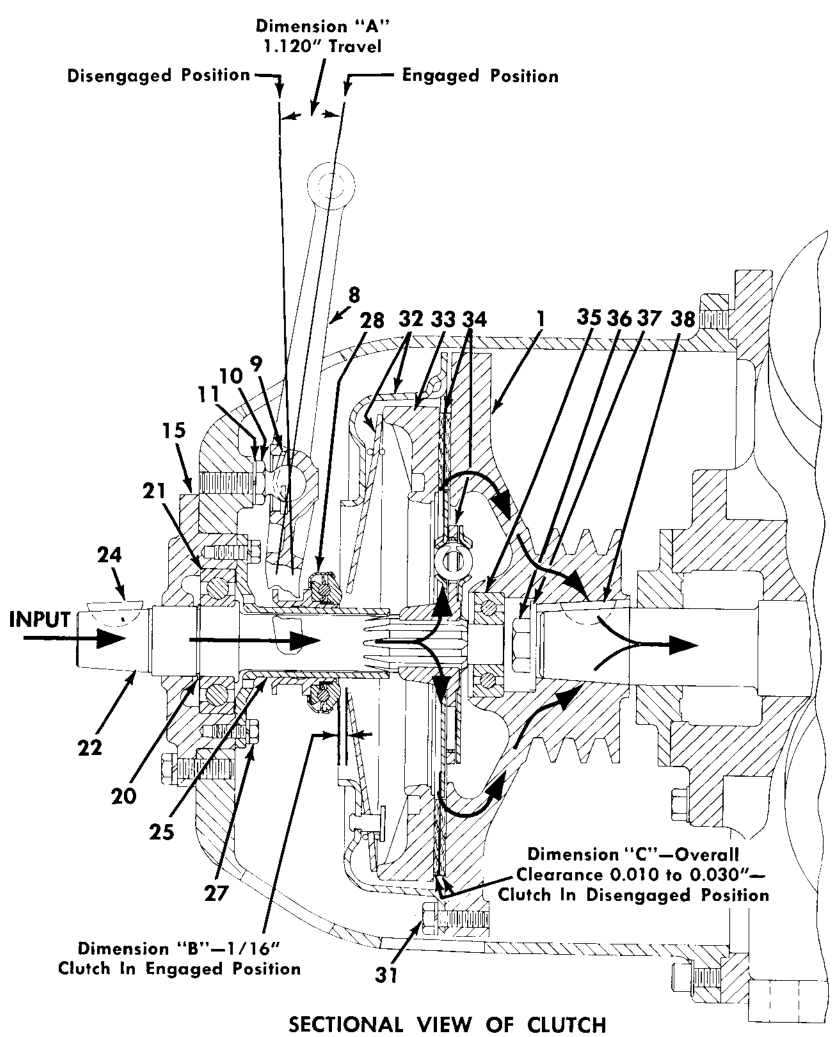
At regular intervals the over-all clearance between the clutch driven plate, the pressure plate, and the compressor flywheel (dimension "C" fig. 95) should be checked. Clearance should measure 0.010" to 0.030". This is accomplished as follows: With clutch disengaged, air cylinder push rod extended, measure plate clearance through hole in bottom of clutch housing and one of the holes in pressure plate cover (fig. 96). Clutch cover must be rotated so that holes will line up to insert feeler. If clearance is not as specified, make adjustment as follows:

With clutch cylinder push rod in the retracted position, or air pressure applied, and with release bearing resting against the Belleville spring, locate yoke on push rod so that hole in clutch release fork is about two-thirds of a hole out of line with hole in yoke, the hole in fork being further away from the air cylinder. Swing release fork so that its hole will line up with yoke hole and insert pin. Extend push rod by shutting off air supply to air cylinder. Push rod should move out a minimum of 1.120 inches (fig. 97). Measure plate clearance through hole in bottom of clutch housing. If clearance is not enough, thread yoke further out on push rod and vice versa.

With clutch in the engaged position (air pressure applied), release bearing should clear the Belleville spring by at least 1/16 inch (dimension "B," fig. 95). If there is less than 1/16 inch it means that more stroke is being applied to spring than is necessary to get .010-.030 inch plate clearance. Distance of release bearing from Belleville spring can be checked by removing pin through yoke and release fork and swinging bearing against spring by hand. Then gradually move bearing away from spring, observing distance the outer end of release



EXPLODED VIEW OF CLUTCH



SECTIONAL VIEW OF CLUTCH

1 Compressor Flywheel
2 Clutch Control Air Cylinder Assy.
3 Lock Nut
4 Yoke
5 Yoke Pin
6 Yoke Pin Retainer Washer
7 Yoke Pin O-ring
8 Clutch Release Fork
9 Retainer Spring
10 Ball Stud
11 External Lock Washer
12 Clutch Housing
13 Housing to Compressor Short Bolts (7 Req'd.)
14 Housing to Compressor Long Bolt (1 Req'd.)
15 Main Bearing Carrier
16 Drive Flange
17 Flange Nut
18 Carrier Attaching Bolts (4)
19 Lock Washer
20 Bearing Retainer Ring
21 Main Bearing Assy.
22 Clutch Shaft
23 Special Flat Washer
24 Drive Flange Key
25 Main Bearing Retainer
26 Lock Washer
27 Retainer Attaching Bolts (4)
28 Clutch Release Bearing Assy.
29 Pressure Plate Retracting Springs
30 Spring Attaching Screws and Washers
31 Cover to Flywheel Bolts and Washers
32 Pressure Plate Cover Assy.
33 Pressure Plate
34 Drive Plate Assy.
35 Clutch Shaft Pilot Bearing Assy.
36 Flywheel to Compressor Bolt
37 Flat Washer
38 Flywheel to Compressor Key

TPM-7257

Figure 95—Compressor Drive Clutch Components

SYSTEM MAINTENANCE

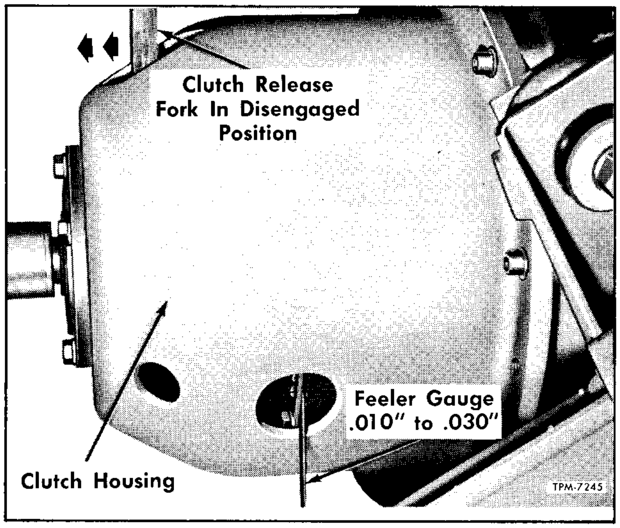


Figure 96—Checking Clutch Drive Plate Clearance

fork travels. A 7/64 inch movement at outer end is equal to 1/16 inch at the inner end. After correct adjustment is obtained, lock jam nut against yoke and place rubber holding washer and O-ring on end of pin (see inset, fig. 97).

COMPRESSOR DRIVE PROPELLER SHAFT

Compressor drive propeller shaft is used to transmit power from engine accessory drive to air conditioning compressor (fig. 93). Fixed-yoke end of shaft is toward engine accessory drive and slip-yoke end of shaft is toward compressor.

Drive shaft is solid type, equipped with needle bearing type universal joints at each end, also a splined slip-yoke to absorb any endwise movement.

DRIVE SHAFT REMOVAL (Refer to Fig. 98)

Remove flange bolts, nuts, and washers from

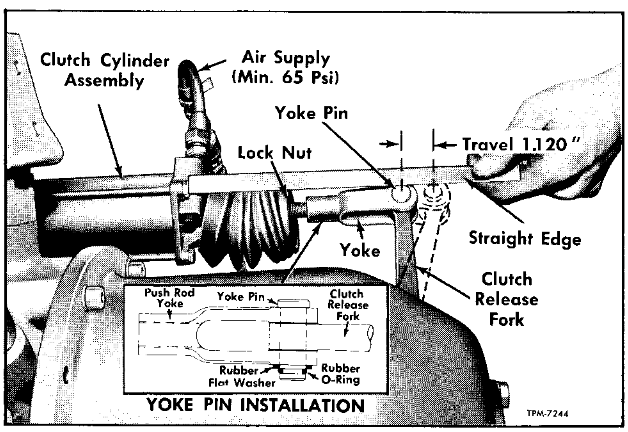


Figure 97—Piston Rod Yoke Adjustment

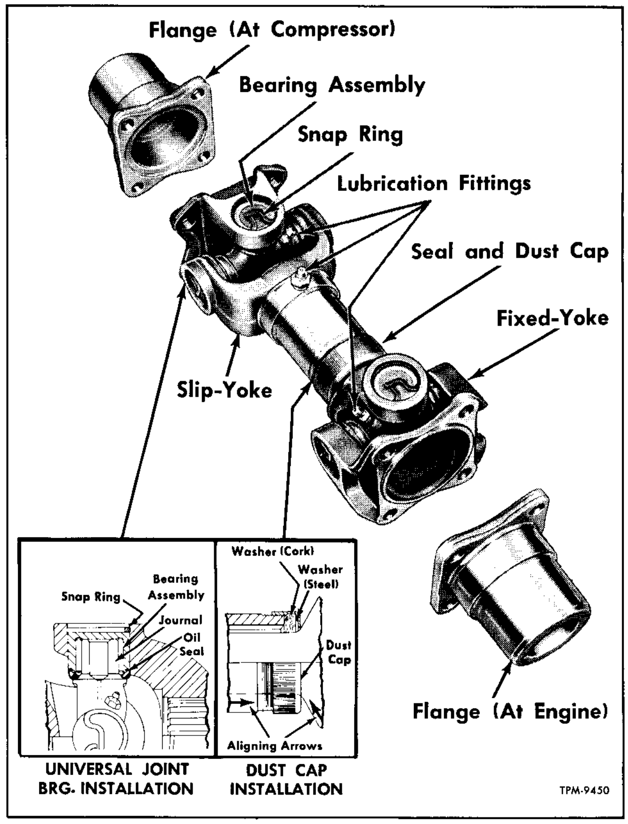


Figure 98—Compressor Drive Shaft Assembly

each end of drive shaft assembly. Remove drive shaft assembly to remove flange at compressor and at engine, remove attaching cotter pin, nut and washer. Remove flange.

DRIVE SHAFT INSTALLATION (Refer to Fig. 98)

If flange at compressor and at engine were removed, install drive key, and flange to shaft. Secure flange with washer and nut. NOTE: At engine flange only, apply oil sealant to surfaces of flange washer and to face of nut. Tighten nut to 100-110 foot-pounds torque. Install nut cotter pin.

Position drive shaft assembly with fixed-yoke end toward engine accessory drive, and slip-yoke end toward compressor. With drive shaft in position, install flange bolts, nuts, and washers. Tighten nuts firmly.

UNIVERSAL JOINT BEARING REPLACEMENT (Refer to Fig. 98)

Removal

1. Remove snap rings which retain bearings in shaft yokes.

2. Strike one side of yoke with soft hammer to force one bearing assembly out of yoke. Strike opposite side of yoke to force opposite bearing out.

CAUTION: DO NOT DROP BEARINGS.

3. Journal can now be tilted to permit removal of yoke from journal.

4. Remove the remaining two bearing assemblies in same manner to permit removing journal from other yoke.

Installation

1. NOTE: Make sure oil seals are in place securing needle rollers in bearing. Apply SAE #140 gear oil to needles to provide initial lubrication.

2. Install journal in yoke, then install bearing assemblies in yoke over journal trunnions. Use a soft hammer to tap bearings into place.

3. Install snap rings into yoke groove to secure bearings in yoke. IMPORTANT: Make sure snap rings are fully seated in yoke grooves.

SLIP YOKE SPLINE SEAL AND DUST CAP REPLACEMENT

1. Separate slip-yoke from fixed-yoke by pulling apart.

2. Unthread dust cap from slip-yoke, then remove dust washer (cork or felt) and flat steel washer from cap.

3. To install, refer to inset on figure 98 for relative position of parts, then place steel washer and dust washer (seal) in cap. Place cap over splines on fixed-yoke.

4. Referring to alignment arrows on sides of slip-yoke and flange of fixed-yoke to see that they are aligned with each other, slide splines of fixed-yoke into slip-yoke. Thread dust cap to end of slip-yoke. Tighten cap until snug.

REFRIGERANT COMPRESSOR DRIVE CLUTCH

The compressor drive clutch (fig. 95) enclosed by an aluminum housing is mounted to drive end of compressor. Clutch is of the conventional automotive type and is actuated by an air powered cylinder assembly mounted to side of compressor.

When air CYLINDER IS PRESSURIZED (push rod retracted), the CLUTCH BECOMES ENGAGED. Likewise when PRESSURE IS EXHAUSTED from cylinder (push rod extended) CLUTCH BECOMES DISENGAGED. NOTE: Air cylinder push rod is extended by pressure of multiple coil springs within cylinder assembly.

The clutch input shaft, which is propeller shaft driven from engine accessory drive is engaged directly to the clutch drive plate assembly. Thus the drive plate is turning whenever the coach engine is running. When clutch is engaged by action of the air cylinder, the Belleville spring of clutch pressure plate is released. This action releases pressure plate to engage both drive plate and compressor flywheel to turn the compressor. Large arrows on figure 95, indicate the power flow from the drive shaft input through the clutch to the compressor.

On all models 4501, 4516, and 4517, the clutch drive plate and cover assemblies only can be replaced without having to break any refrigerant lines or having to remove the compressor from coach. See "Clutch Drive Plate and Cover Assembly Replacement (Compressor in Coach) (All Models 4501, 4516, and 4517)."

On all models 5301 and 5302, all of the clutch components can be replaced without having to remove compressor from coach. See "Clutch Housing, Drive, Plate, and Cover Assemblies Replacement (Compressor in Coach) (All Models 5301 and 5302)."

Overhaul of the clutch components are explained later under "Clutch Overhaul."

CLUTCH DRIVE PLATE AND COVER ASSEMBLY REPLACEMENT (COMPRESSOR IN COACH)

(All Models 4501, 4516, and 4517)

NOTE: The following describes procedure for replacing drive plate and cover assemblies only, and does not cover replacement of the aluminum clutch housing. In order to remove housing, it is first necessary to remove the complete compressor unit from coach.

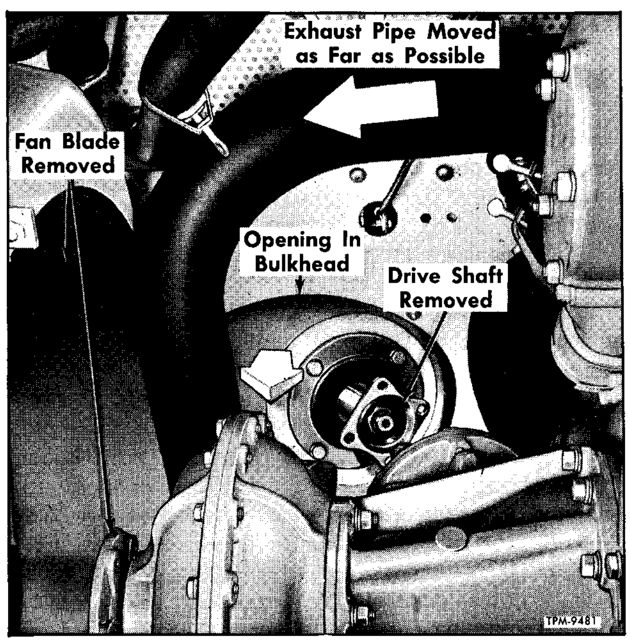
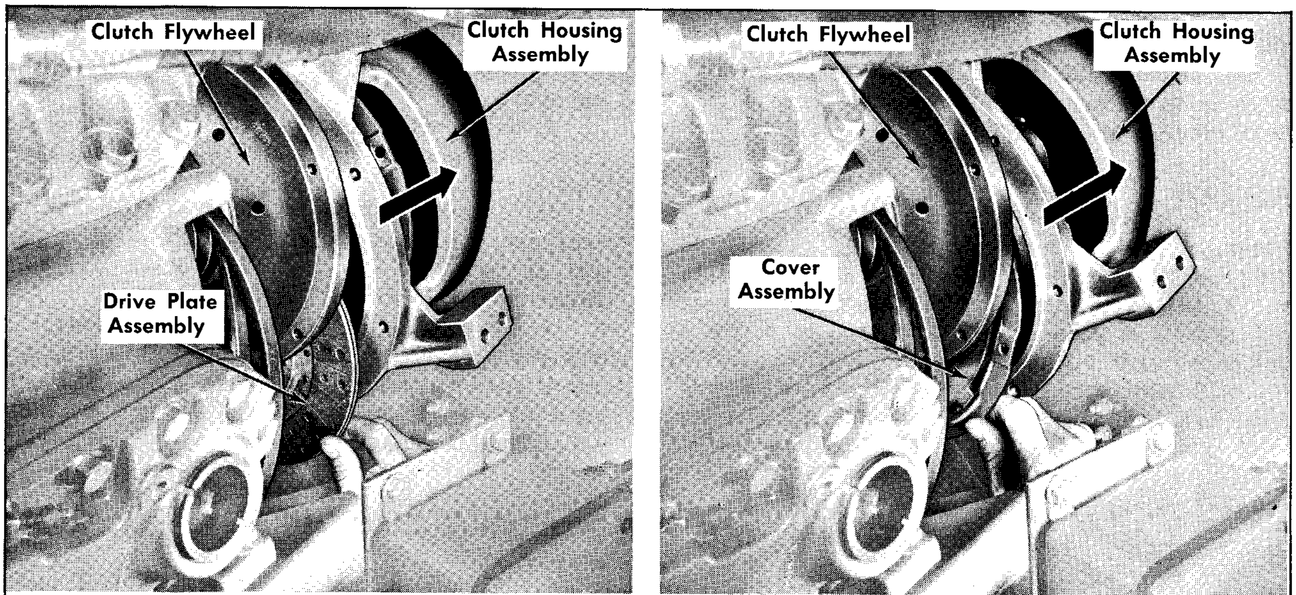


Figure 99—Access To Clutch Housing Through Engine Compartment

SYSTEM MAINTENANCE



REPLACING CLUTCH DRIVE PLATE ASSEMBLY   REPLACING CLUTCH COVER ASSEMBLY

Figure 100—Replacing Clutch Drive Plate and Cover (Compressor in Coach)

IMPORTANT: One special tool, which can be improvised locally is necessary for making these replacements. DO NOT ATTEMPT TO MAKE REPLACEMENTS UNLESS THIS TOOL IS AVAILABLE. Tool is used for holding drive plate in alignment when installing cover assembly to clutch flywheel. Cut off a portion of an old clutch shaft (22, fig. 95) at a point shown in figure 101. Same like part can be made up from an old Chevrolet mechanical transmission main drive (clutch) gear.

DRIVE PLATE AND COVER REMOVAL

1. Using run-up blocks, raise rear of coach to provide access from below compressor compartment. Set hand brake.
2. Place engine control switches in engine compartment to "OFF" position.
3. Remove stone shield from below compressor and from under engine at left side.
4. Remove muffler assembly from engine compartment. This will provide access to compressor drive shaft.
5. Remove fan blade from engine. Through access hole in seat-back above engine, disconnect exhaust pipe from exhaust manifold. Also loosen exhaust pipe at muffler base. Move exhaust pipe toward radiator as far as possible. See figure 99.
6. Remove compressor drive shaft assembly. NOTE: If necessary to rotate shaft for access to flange bolts, turn engine crankshaft using a 1-1/2 inch socket wrench on lower camshaft pulley nut.
7. Spring-loaded clutch cylinder (2, fig. 95) must be disconnected from clutch release fork (8, fig. 95). In order to remove fork connecting pin (5, fig. 95), disconnect cylinder air line hose at air control solenoid valve, then apply shop air pressure through hose into air cylinder (min. air pressure required - 65 lbs.). This action will relieve pressure on cylinder yoke pin, allowing pin to be removed.
8. Remove condenser fan drive pump from compressor clutch housing as directed previously under "Fan Drive Pump Replacement."
9. Remove cover from access hole in coach floor above compressor. This will provide access to clutch housing upper attaching bolts.
10. Remove socket head bolts (13 and 14, fig. 95) which attach clutch housing to compressor. Using two of these screws installed into tapped holes, one at top, and bottom of housing, separate housing evenly from compressor.

NOTE: On some early coaches, it may be necessary to remove radiator surge tank overflow line from opening in engine bulkhead before moving clutch housing rearward.

10. Referring to figure 99, move clutch housing rearward into propeller shaft opening in body bulkhead. With the aid of an assistant to retain housing in position, remove cover attaching bolts, then work clutch drive plate and cover assembly from clutch housing in manner shown in figure 100.

INSTALLATION OF DRIVE PLATE AND COVER

NOTE: While clutch housing is separated from compressor, examine and if necessary replace fluid pump drive belts. See figure 120.

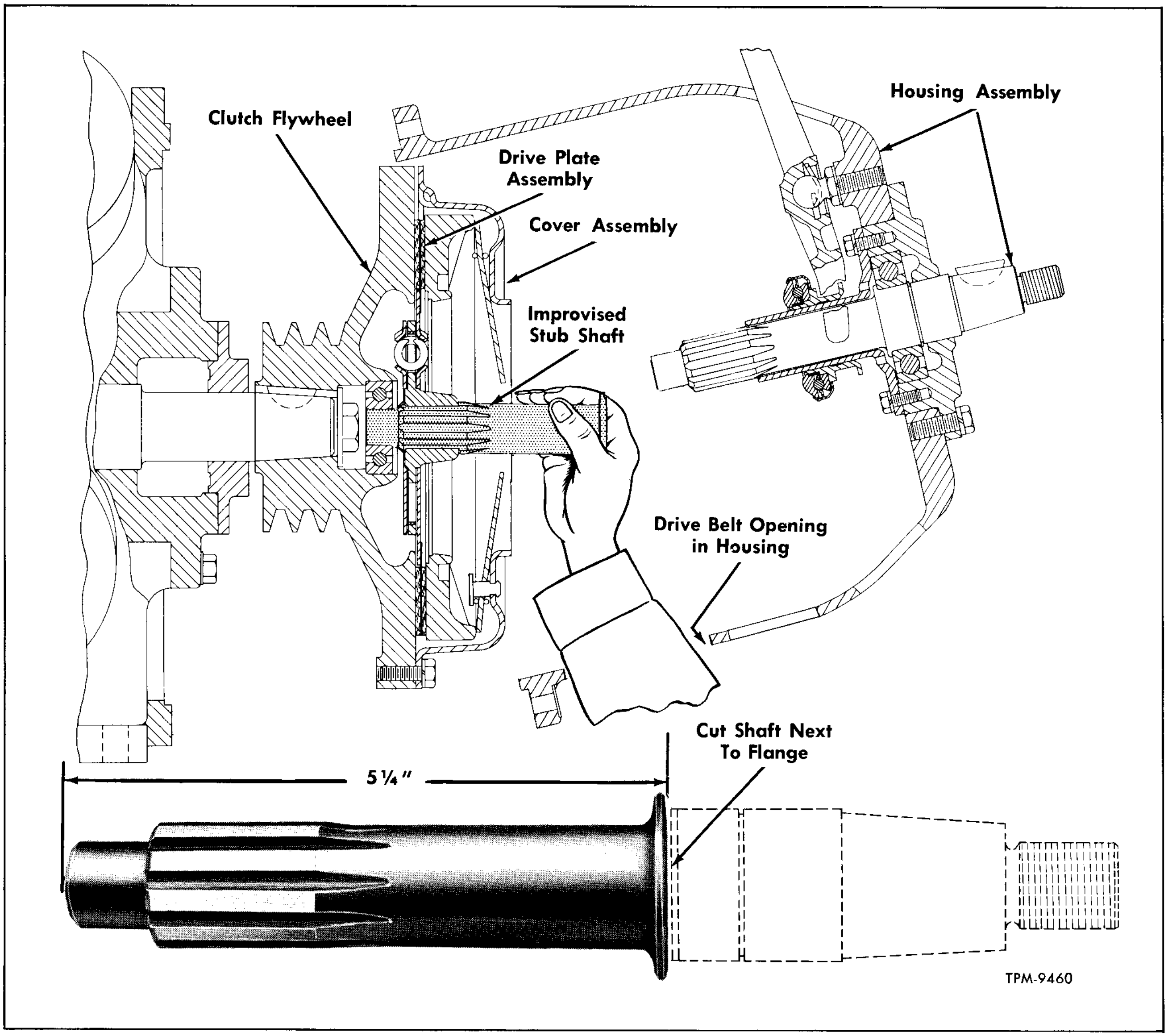


Figure 101—Installing Clutch Drive Plate and Cover Using Alignment Tool (Compressor in Coach)

IMPORTANT: If new belts are to be installed make sure they are all from same service set. DO NOT USE OLD AND NEW BELTS TOGETHER.

NOTE: The aid of an assistant is recommended when installing clutch components.

1. Referring to figure 100, insert clutch cover and drive plate into clutch housing as shown.
2. Using improvised stub shaft as shown in figure 101, insert shaft into splines of drive plate and then into pilot bearing within clutch flywheel.

NOTE: Clutch housing must be located slightly out of alignment with compressor (See upper view) in order to use the alignment stub shaft as existing shaft within housing will interfere.

3. Carefully line up clutch cover with flywheel then install cover attaching bolts and lock washers alternately. This will prevent distorting clutch cover when compressing clutch spring.

IMPORTANT: If a new cover assembly was installed, pry three shipping blocks from around cover. Blocks are located as shown in figure 106.

NOTE: Cover attaching bolts should be tightened to approximately 40 foot-pounds torque. Remove improvised stub shaft from clutch drive plate.

4. While assistant rotates the clutch shaft from the engine compartment, engage splines of clutch shaft into drive plate and into pilot bearing in flywheel.
5. Install clutch housing evenly to compressor using socket head bolts and special flat washers.

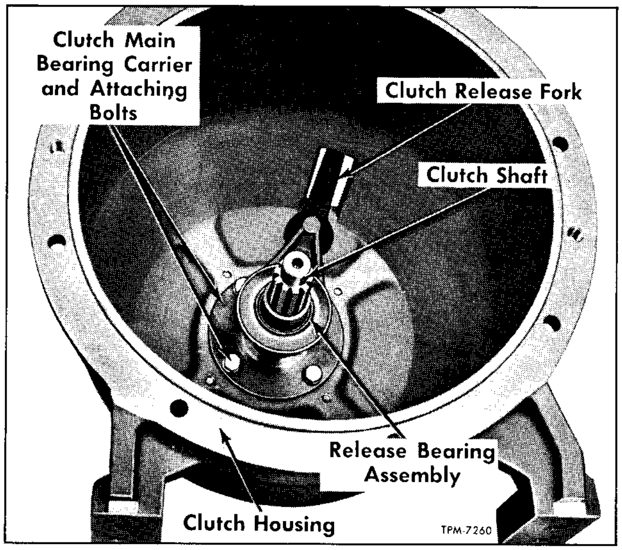


Figure 102—Clutch Fork and Drive Shaft Installed in Clutch Housing

NOTE: Install longer attaching bolt at location shown in figure 95. See item 14.

6. Apply shop air pressure to clutch control air cylinder, then install cylinder to release fork clevis pin, pin (washer) retainer, and rubber O-ring (5, 6, and 7, fig. 95). Attach cylinder air line to air control solenoid valve.

7. Install condenser fan drive pump and bracket assembly to clutch housing as directed previoutly under "Fan Drive Pump Replacement."

8. Install compressor drive shaft assembly. IMPORTANT: Make sure the slip yoke end of shaft assembly is positioned toward the compressor (see fig. 98). NOTE: If necessary to rotate engine flange for alignment see step 6 under "Drive Plate and Cover Removal."

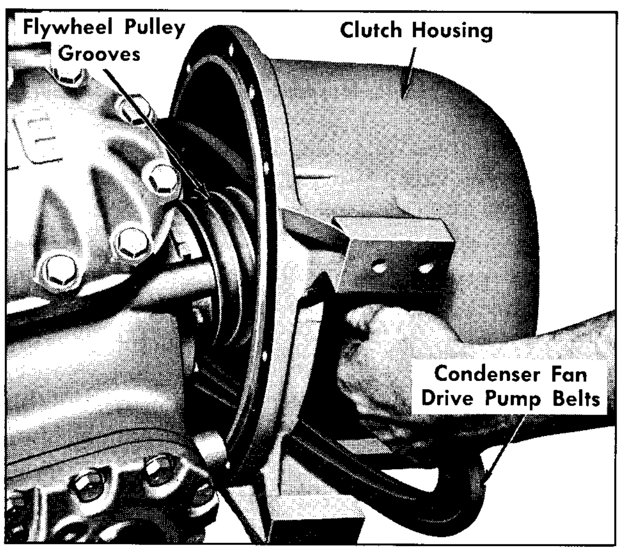


Figure 103—Installing Clutch Housing

9. Install muffler assembly.

10. Fasten stone shields under compressor and engine.

11. Place engine control switches in the engine compartment in operating positions.

12. Remove coach from run-up blocks.

CLUTCH HOUSING, DRIVE PLATE AND COVER ASSEMBLY REPLACEMENT (COMPRESSOR IN COACH)

(All Models 5301 and 5302)

NOTE: The clutch drive plate and cover assemblies can be replaced in same manner as directed previously for models 4501, 4516, and 4517; however, on models 5301 and 5302, having more area in the compressor compartment, the compressor and clutch assembly can be moved forward on its mounting platform and then all of the clutch components can be readily replaced. This procedure will not necessitate the breaking of any refrigerant line connections.

REMOVAL

1. Perform Removal Steps 1 through 9, explained previously under "Clutch Drive Plate and Cover Assembly Replacement (Compressor in Coach) (All Models 4501, 4516, and 4517)."

2. Remove four bolts, nuts, and washers which attach legs of compressor to mounting platform. Carefully raise compressor slightly and slide a sheet of plywood under compressor assembly.

3. Move compressor forward in compartment, being careful not to damage refrigerant lines and connections.

4. Remove socket head bolts (13 and 14, fig. 95) which attach clutch housing to compressor. Using two of these screws installed into tapped holes, one at top, and bottom of housing, separate housing evenly from compressor. Remove housing assembly from compartment.

5. Remove and repair clutch components as directed later under "Clutch Overhaul."

INSTALLATION

1. Install clutch components to compressor as directed later under "Clutch Overhaul."

2. Carefully slide compressor with assembled clutch unit rearward to regular mounting location. Remove plywood sheet from below compressor. Install four bolts, washers, and nuts which attach compressor legs to mounting platform. Tighten bolts firmly.

3. Perform Installation Steps 6 through 12, explained previously under "Clutch Drive Plate and Cover Assembly Replacement (Compressor in Coach) (All Models 4501, 4516, and 4517)."

CLUTCH OVERHAUL

CLUTCH HOUSING AND SHAFT ASSEMBLY REPLACEMENT (COMPRESSOR REMOVED FROM COACH)

NOTE: Key numbers in following text refer to figure 95.

Removal

1. Apply shop air pressure to clutch control air cylinder (min. air pressure required - 65 psi). This action will relieve pressure on yoke pin at end of release fork. Remove yoke pin.
2. Remove socket head screws (13 and 14), which attach clutch housing (12) to compressor. Using two puller screws installed into tapped holes near top and bottom of clutch housing, remove housing evenly from compressor. Figure 102 shows housing with shaft removed. Remove pump drive belts from compressor flywheel pulley.

Installation

1. With three condenser fan drive belts located in clutch housing as shown in figure 103, position clutch housing assembly to compressor. Install eight attaching bolts (13 and 14) with special flat washers (23).

NOTE: A single long bolt (14) is installed into hole shown on figure 95. Tighten bolts to 20 foot-pounds torque.

CLUTCH HOUSING AND SHAFT DISASSEMBLY (Refer to Fig. 102)

1. Using a flange holding tool (fig. 104), remove nut (17) from drive flange (16). Remove flange and flange key (24).
2. Using a suitable wrench, turn ball stud (10) and lock washer (11) from clutch housing. Remove stud with clutch release fork (8). Slide release bearing (28) from retainer (25). Remove retainer spring (9) holding ball stud in fork.
3. Remove four bolts (18) and lock washers (19) which attach main bearing carrier with shaft as a unit from housing.
4. Remove four bolts (27) and lock washer (26) attaching main bearing retainer (25) to main bearing carrier. Remove retainer and carrier from clutch shaft (22).
5. Using snap ring pliers, remove bearing retainer ring (20) from clutch shaft. Using arbor press, force main bearing assembly (21) from shaft.

CLUTCH HOUSING AND SHAFT ASSEMBLY

1. Press main bearing assembly (21) onto clutch shaft (22) making sure unshielded side of bearing is toward flange on shaft.
2. Install bearing retainer ring (20) into ring

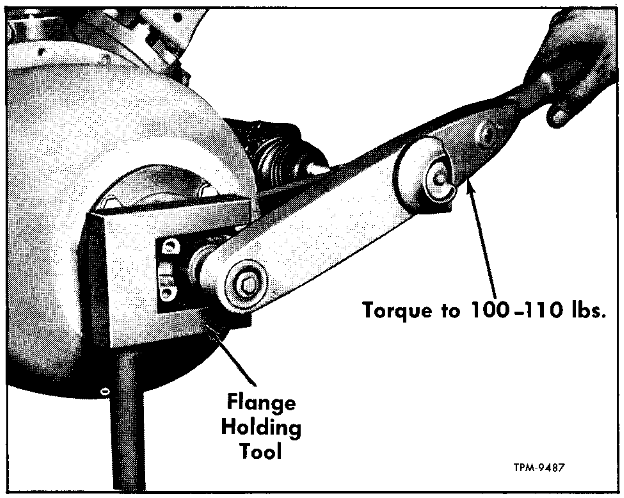


Figure 104—Replacing Drive Shaft Flange Nut

groove on shaft.

3. Pack cavity of main bearing carrier (15) with #2 - 3% Moly grease. Referring to figure 95 for position of parts, place carrier on shaft, then position main bearing retainer over bearing. Install retainer to carrier with four bolts (27) and lock washers (26). Tighten bolts firmly.
4. Install carrier (15) with shaft (22) into clutch housing with four bolts (18) and lock washers (19). Tighten bolts evenly and firmly.
5. Pack ball stud socket of clutch release fork (8) with wheel bearing grease, then insert ball stud (10) into socket. Secure stud with retainer spring (9). Make sure both ends of spring are located in fork.
6. Slide clutch release bearing (28) over main bearing retainer to position shown in sectional view of figure 95.

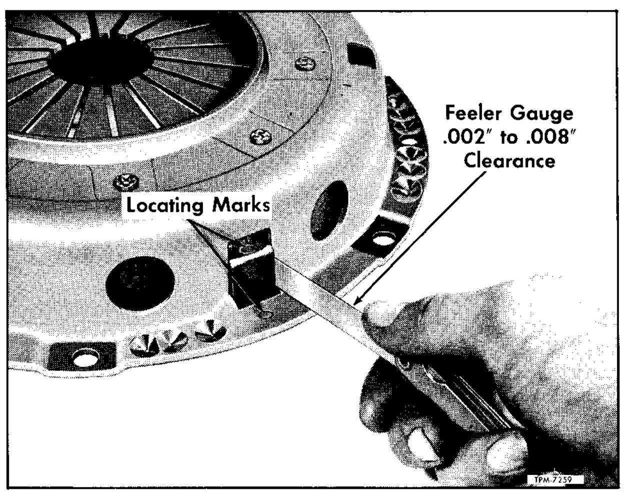


Figure 105—Clutch Cover To Plate Alignment Marks and Driving Lug Clearance Check

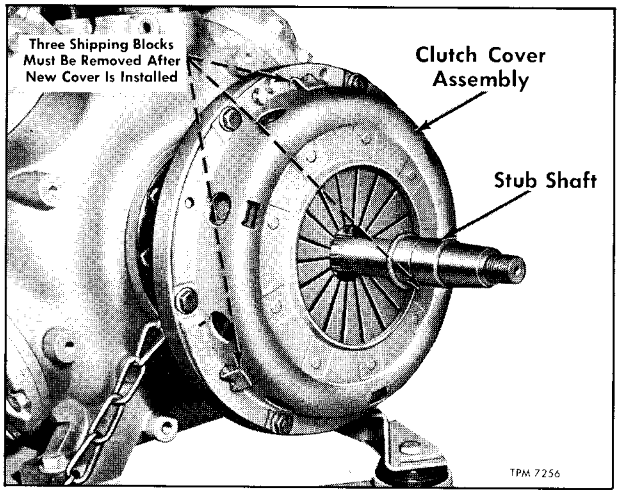


Figure 106—Using Stub Shaft To Align Clutch Components

7. Install clutch release fork (8) to clutch housing, using new external lock washer on ball stud. Tighten stud firmly. Figure 102 shows assembly built up.

8. Install compressor drive shaft flange (16) with key (24) to clutch and secure with flange nut (17). Using flange holding tool shown in figure 104, torque flange nut to 100-110 foot-pounds.

CLUTCH DRIVE PLATE, PRESSURE PLATE AND COVER REMOVAL AND DISASSEMBLY

1. Loosen cover to compressor flywheel bolts (31) one turn at a time until clutch spring pressure is released, then carefully remove clutch cover assembly (32) and drive plate (34).

NOTE: Check clearance between driving lugs of pressure plate (23) and mating slots in clutch cover (32) in manner shown in figure 105. If clearance is greater than .008", examine cover and lugs of pressure plate for wear and if necessary, replace worn parts.

If locating marks "O" on cover and pressure plate (fig. 105) are not visible, mark parts as shown. Remove pressure plate retracting spring bolts (30), remove springs (29), then separate pressure plate from cover.

NOTE: Pressure plate can be resurfaced as directed later under "Inspection and Repair."

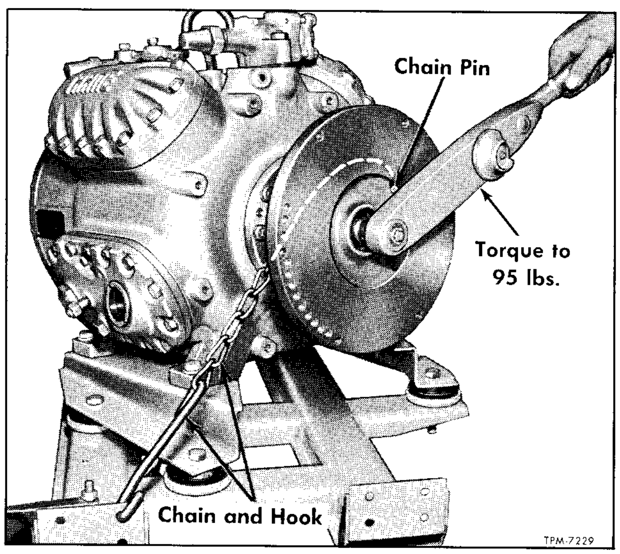


Figure 107—Tightening Compressor Flywheel Bolt

CLUTCH DRIVE PLATE, PRESSURE PLATE AND COVER ASSEMBLY AND INSTALLATION

1. Apply light coat of graphite grease on sides of pressure plate driving lugs; then install plate in cover, making sure balance mark "O" on cover (32) is matched with corresponding mark on pressure plate (33). Refer to figure 105.

2. Install three retracting springs (29) on pressure plate (33). There must not be any clearance between clutch spring and retracting spring when spring attaching screws are tight.

3. Making sure clutch wear friction surfaces are free of grease and dirt, set drive plate (34) in place against flywheel with extended portion of hub away from flywheel. While holding plate in place, move cover assembly (32) with pressure plate (33) into place against flywheel. Using a stub shaft as shown in figure 106 to align clutch drive plate, install cover attaching bolts (31) with lock washers alternately to compress clutch spring evenly and prevent possible distortion of cover flange. Remove stub shaft when all bolts are tightened to 40 lbs. torque. IMPORTANT: If a new cover assembly was installed, pry three shipping blocks from around cover. Blocks are located as shown in figure 106.

CLUTCH FLYWHEEL AND PILOT BEARING REPLACEMENT

Removal

1. Remove pilot bearing (35) from compressor flywheel using convention bearing puller tool.

2. Using proper size wrench socket, remove bolt (36) and flat washer (37) which attach flywheel (1) to compressor shaft (fig. 107). Remove flywheel and flywheel key (38).

Installation

1. Insert drive key (38) into slot of compressor crankshaft, then with flywheel aligned, position flywheel to compressor. Install flywheel flat washer (37) and special bolt (36). Tighten bolt to 95 lbs. torque in manner shown in figure 107.

NOTE: Flywheel can be retained when tightening bolt, using a large size cotter pin on a link of

chain. Engage pin into hole at back side of flywheel and hook the other end of chain to compressor platform as shown.

2. Pack cavity around head of flywheel attaching bolt with #2 - 3% Moly grease; then press pilot bearing (35) evenly into clywheel.

IMPORTANT

Shielded side of bearing must face cavity.

INSPECTION AND REPAIR

NOTE: Key numbers in text refer to figure 95.

1. Wash all parts in cleaning solvent, except bearings and clutch drive plate assembly (34).

2. Carefully examine clutch cover and spring assembly (32). Check spring for wear at inner end of levers at point contacted by release bearing (28). Also look for wear and fractures at outer rim of clutch spring. Replace complete cover and spring assembly if any of the component parts are damaged or worn.

3. Inspect pressure plate (33) for scoring on contact surface. Regrind pressure plate if plate is grooved, rough, heat checked, or cracked. Replace with new plate if distorted or if driving lugs are worn.

4. Inspect contact surface of compressor flywheel (1) for grooved, or worn condition. Flywheel can also be ground down as explained later.

5. Replace pilot bearing (35) clutch release bearing (28) and clutch shaft main bearing (21) if bearings are rough or damaged.

RESURFACING PRESSURE PLATE

Before resurfacing pressure plate a check should be made to determine whether plate has been resurfaced previously. This may be determined by measuring from the front surface of plate to the surface at rear side which is contacted by the Belleville spring. Dimension of new pressure plate is 1.0945" to 1.0970". Not more than .045 inch of stock may be removed from contact surface by grinding. If pressure plate is to be resurfaced, proceed as follows:

1. Grind off friction surface of pressure plate as necessary to produce a flat surface. If necessary to reduce plate thickness more than .045 inch to restore smooth flat surface, plate should be discarded and replaced with a new part.

2. After plate has been resurfaced, measure thickness as directed above. Subtract thickness of resurfaced plate from thickness of new plate to determine how much stock has been removed during resurfacing operation.

RESURFACING COMPRESSOR FLYWHEEL

Remove flywheel from compressor and grind from wear surface of flywheel rim, the same amount of stock as was removed from pressure plate. The last operation is necessary in order to maintain torque capacity of clutch and assure proper operation of clutch spring. When refacing is done properly, the clutch spring will be flat when clutch parts are assembled to flywheel, that is; the inner end of fingers will be in same plane as the outer rim of spring, or fingers may slant slightly rearward.

CLUTCH CONTROL AIR CYLINDER

Clutch control air cylinder (fig. 108), pivot-mounted to side of compressor is employed to engage and disengage the compressor clutch. When cylinder push rod is retracted by air pressure supplied by the control air solenoid valve, clutch becomes engaged. When solenoid valve closes, exhausting air supply to cylinder, springs within cylinder extend the push rod to cause clutch to become disengaged.

Air, which is drawn into vented end of air cylinder when clutch is disengaged, enters through an air strainer assembly, mounted to pivot end of cylinder. Air strainer should be removed and cleaned after every three months of operation or more often if subject to operation under extreme dusty conditions.

AIR CYLINDER REMOVAL

1. Disconnect coach air supply line at air cylinder and apply shop air pressure to cylinder to free clevis pin at clutch release fork.

2. Remove rubber O-ring, and flat rubber washer at lower end of cylinder push rod yoke pin. Remove pin from yoke and clutch release fork, then disconnect shop air pressure from cylinder.

3. Remove pin which attaches pivot-end of cylinder to compressor bracket. Carefully lower cylinder from compartment.

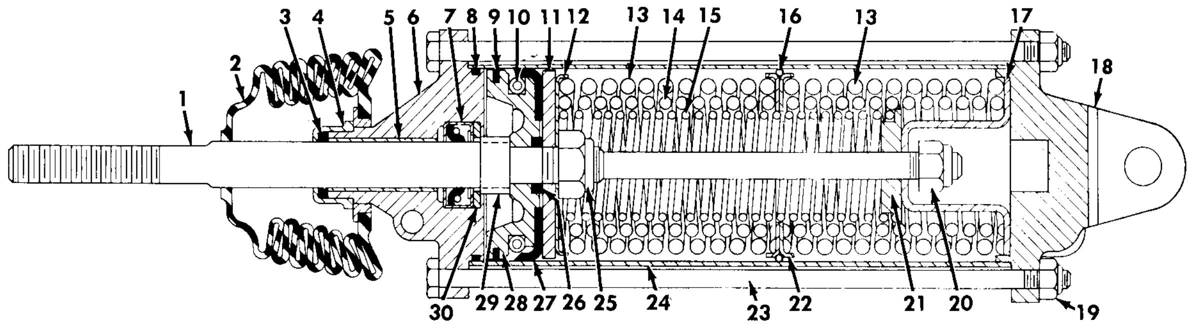
4. If necessary, remove air strainer assembly from rear cover of cylinder. Instructions for cleaning air strainer are explained later under "Cylinder Air Strainer."

AIR CYLINDER INSTALLATION

NOTE: Alignment of air cylinder pivot bracket with clutch release fork should be checked, to prevent push rod binding, before cylinder is installed as shown in figure 109. This check is necessary especially if the bolts attaching pivot bracket to compressor have been loosened, allowing bracket to tilt out of alignment.

1. Align clutch control air cylinder pivot

SYSTEM MAINTENANCE



1 Push Rod	9 Piston Felt	17 Spring Retainer Cup	25 Push Rod Nut
2 Push Rod Boot	10 Expander Spring	18 Rear Cover	26 O-ring
3 Seal	11 Piston Plate	19 Nut	27 Piston Cup
4 Seal Cap	12 Spring Retainer	20 Push Rod Nut	28 Piston Follower
5 Push Rod Bushing	13 Spring (Large Dia.)	21 Spring Seat	29 Spacer
6 Front Cover Assy.	14 Spring (Med. Dia.)	22 Spring Retainer Assy.	30 Seal Washer
7 Push Rod Seal Assy.	15 Spring (Small Dia.)	23 Bolt	
8 Tube O-ring	16 Anti-friction Ring	24 Cylinder Tube	TPM-7023

Figure 108—Clutch Control Air Cylinder Assembly

bracket with clutch release fork using a piece of straight bar stock positioned on bracket and fork as shown. If entire top surface of pivot bracket is not contacting bar, loosen bracket attaching bolts and allow bracket to align. Tighten bolts firmly after bracket is properly aligned.

2. Apply small quantity of Lubriplate to pivot end of cylinder and to yoke at push rod end of cylinder.

3. Raise cylinder assembly into position. Attach pivot end to mounting bracket with pin.

4. Connect shop air supply line to air cylinder to retract cylinder push rod.

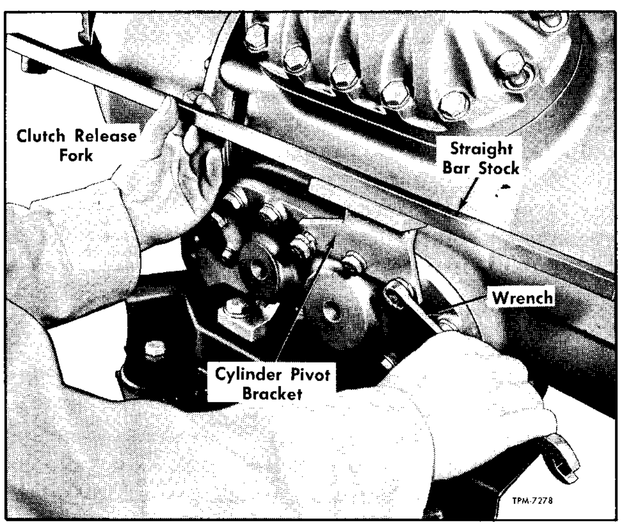


Figure 109—Checking Air Cylinder Mounting Bracket Alignment

5. Check and adjust clutch control as explained previously under "Clutch Release Adjustment."

6. After proper adjustment is obtained make certain that flat rubber washer and rubber O-ring (6 and 7, fig. 95) are installed to lower end of push rod yoke pin. See inset on figure 97.

CYLINDER OVERHAUL

DISASSEMBLY

NOTE: Key numbers in text refer to figure 108.

1. Mark cylinder front cover (6), cylinder tube (24), and rear cover (18) so as to assure proper alignment when assembled later.

2. Remove boot (2) from push rod and cover.

3. Remove nut (19) from ends of four bolts (23) retaining cylinder assembly together. Remove bolts.

4. Separate front cover (6) with push rod and springs from cylinder tube and rear cover. Slide front cover (6) from push rod being careful not to damage push rod seal (7).

5. Remove O-ring (8) from groove of cover.

NOTE: At this point of disassembly, anti-friction ring (16) can be removed and condition of piston components can be checked. To disassemble piston components, an arbor press having sufficient travel is necessary for compressing springs to allow removal of inner push rod nut (20).

CAUTION: DO NOT ATTEMPT TO DISASSEMBLE OR ASSEMBLE SPRINGS WITHOUT PROPER EQUIPMENT AS SERIOUS INJURY COULD RESULT.

6. Using arbor press with a suitable fixture that will prevent the springs from "snaking" out of position, remove push rod nut (20). Carefully back off arbor press to remove tension on springs. Remove spring retainer cup (17), spring seat (21) and all springs with spring retainer assembly (22).

7. Remove push rod nut (25), then remove spring retainer (12), piston plate (11), piston cup (27), expander spring (10) and piston felt (9).

8. O-ring (26) can be removed from piston follower (28).

9. Slide spacer (29) from push rod.

10. If necessary, seal washer (30) and seal assembly (7) can be removed from front cover (6).

CLEANING AND INSPECTION

Clean all parts thoroughly, then inspect cylinder tube (24) and piston cup (27).

ASSEMBLY

NOTE: Key numbers in text refer to figure 108. Refer to this view for positioning of parts when assembling unit.

1. Install new seal assembly (7) into front cover (6). Install seal washer (30). Stake washer in four places.

2. Slide small diameter end of push rod (1) into boot end of front cover (6) and through seal.

3. Place spacer (29) into position on push rod.

4. Place piston follower (28) on push rod, then install small O-ring (26) into recess of follower.

5. Referring to figure 108 for proper positioning of parts, install piston felt (9) and expander spring (10) into grooves of follower (28). Install piston cup (27), piston plate (11), spring retainer (12) and new push rod nut (25). Tighten nut firmly.

6. Place push rod and front cover in arbor press fixture, then position springs (14 and 15), and two larger diameter springs (13) with spring retainer (22) located between springs. Locate spring seat (21) with flange positioned as shown, then carefully press seat and spring retainer cup (17) over end of push rod to allow installation of new push rod nut (20). Tighten nut firmly.

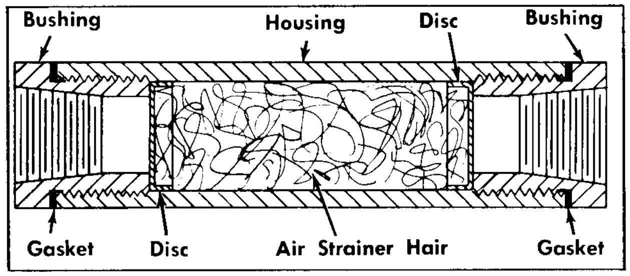


Figure 110—Air Strainer Assembly

7. Locate tube O-ring (8) into groove of front cover and place anti-friction ring (16) into groove of spring retainer (22).

8. Coat inside of cylinder tube (24) with Lubriplate, then place tube over springs to front cover. Locate rear cover (18) to tube. Align marks on tube and covers which were made prior to disassembly. Install four bolts (23) and nuts (19). Tighten nuts evenly.

9. If previously removed, install seal (3) and seal cap (4).

10. Apply small quantity of clean grease to push rod, then install push rod boot (2) to front cover.

CYLINDER AIR STRAINER

Air strainer (fig. 110), installed at pivot end of air cylinder, should be removed and cleaned after every three months of operation or more often if subject to extreme dusty conditions.

Soak strainer material in cleaning solution, then flush strainer. Allow material to dry, then assemble strainer. Replace gaskets if necessary. Tighten end bushings firmly. Install strainer to air cylinder.

COMPRESSOR ACCESSORY DRIVE

The accessory drive, as used to transfer power of coach engine to operate the air conditioning refrigerant compressor, consists of a bevel drive gear and pinion enclosed within engine fan drive housing, as shown in figure 93. Sectional view of gears installed in housing is shown in figure 111.

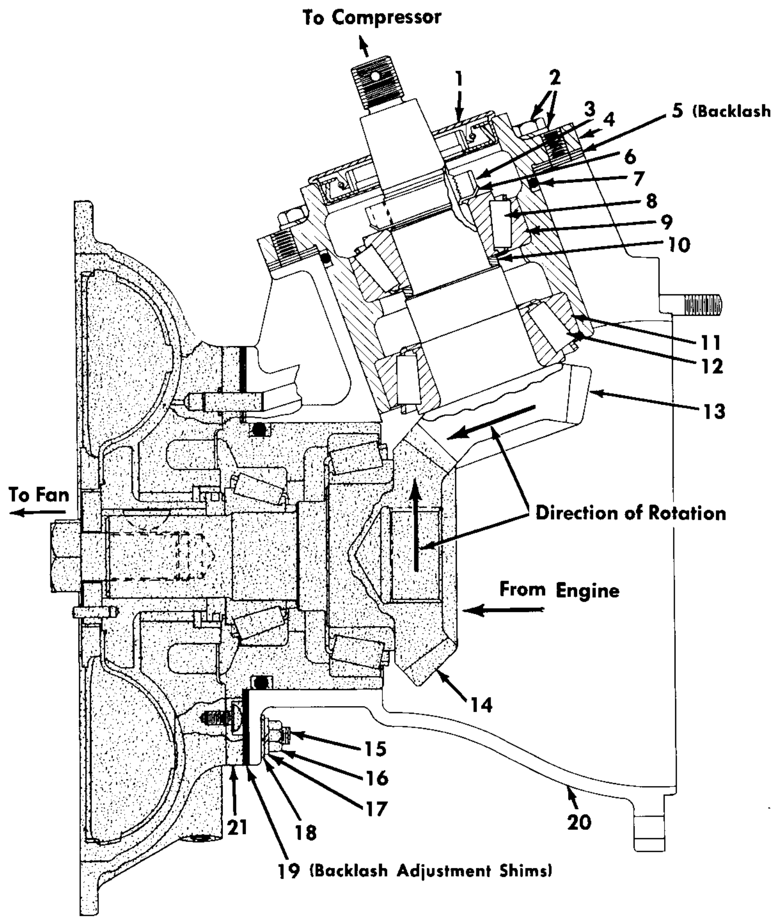
Referring to figure 111, engine torque is transferred from fan drive pinion (14) to the bevel gear (13) at a ratio of 1.388 to 1 on all models except model SDM5301 with 8-cylinder engine which has a ratio of 1.588 to 1.

Bevel gear (13, fig. 111) is supported in bearing retainer (4, fig. 111) on two taper roller bearings which are lubricated by engine oil pressure through internal drilled passages. Bearing retainers (4 and 21, fig. 111) of both gears can be .001" press fit or .001" loose fit in opening of accessory drive housing (20, fig. 111).

BEVEL GEAR AND PINION ARE USED IN MATCHED SETS ONLY.

Adjustment of gear backlash and tooth contact is accomplished by removing or adding shims (5 and 19, fig. 111) which relocate position of one gear in relation to the other. Instructions for making adjustments are explained later under "Bevel Gear and Pinion Adjustments."

The following information applies to removal, disassembly, cleaning and inspection, assembly



1 Oil Seal Assy.
2 Bearing Retainer Attaching Bolts and Lock Washers
3 Bearing Adjustment Nut
4 Bearing Retainer
5 Backlash Adjustment Shims
6 Adjustment Nut Lock
7 Bearing Retainer O-ring Seal
8 Outer Bearing Cone Assy.
9 Outer Bearing Cup
10 Bearing Adjustment Spacer (Variable Thickness)
11 Inner Bearing Cup
12 Inner Bearing Cone Assy.
13 Bevel Gear
14 Bevel Pinion with Bearing Retainer and Fan Drive Unit
15 Stud
16 Nut
17 Lock Washer
18 Flat Washer
19 Backlash Adjustment Shims
20 Accessory Drive Housing
21 Fan Drive Bearing Retainer

TPM-7220-1

Figure 111—Compressor Accessory Drive

and installation of the bevel gear and bearing retainer unit only. For information on fan drive bevel pinion and bearing retainer unit, refer to current Diesel Engine Maintenance Manual.

BEVEL GEAR AND BEARING RETAINER REMOVAL

NOTE: Key numbers in text refer to figure 111.

1. Remove nut which attaches propeller shaft flange to drive gear (13). Remove flange and flange key.
2. Mark position of bearing retainer (4) in relation to accessory drive housing to assure original position when assembled later.
3. Install two puller screws into tapped holes in bearing retainer (4) and force bearing retainer evenly from housing. Remove puller screws. Retain shim pack (5) to assure original gear backlash if it was found satisfactory.
4. Disassemble bevel gear and retainer unit as explained later under "Bevel Gear and Bearing Retainer Disassembly."

BEVEL GEAR AND BEARING RETAINER DISASSEMBLY

NOTE: Key numbers in text refer to figure 111.

1. Remove O-ring seal (7) from groove in bearing retainer.
2. Using sharp bladed tool pry oil seal assembly (1) from bearing retainer.
3. Bend down tab of adjustment nut lock (6).
4. Position bevel gear assembly in a vise having soft jaws, then using a spanner wrench, remove adjustment nut (3). Remove nut lock (6).
5. Support bevel gear retainer (4) in an arbor press and force bevel gear (13) with inner bearing cone (12) and bearing adjustment spacer (10) from retainer. Remove spacer (10) from shaft. If inner bearing needs replacement, remove bearing using arbor press and remover plates.
6. Remove outer bearing cone assembly (8) from retainer.
7. If necessary, bearing cups (9 and 11) can be removed from retainer, using suitable equipment.

CLEANING AND INSPECTION

1. Clean all parts in cleaning solvent. Wipe or blow parts dry.
2. Inspect rollers of bearing cones for nicks and worn spots. Inspect bearing cups also for indication of wear. Replace cones and cups if not in good condition. After cleaning and inspection of bearing parts, lubricate parts generously with clean engine oil, then wrap in clean lint-free cloth or paper until ready to install.
3. Check teeth of bevel gear for poor tooth contact pattern, nicks, or worn condition. NOTE: Bevel gear and pinion are serviced in matched set only.

ASSEMBLY OF BEVEL GEAR AND BEARING RETAINER

NOTE: Key numbers in text refer to figure 111. Coat all parts in clean SAE 30 engine lubricant when assembling unit.

1. If bevel gear inner bearing cone (12) was removed from bevel gear at disassembly, install inner bearing cone using a suitable sleeve and arbor press. Support bevel gear on soft metal or hardwood block and seat bearing race firmly at shoulder (fig. 112).
2. Install bearing adjustment spacer (10) on shaft of bevel gear.
3. Inspect counterbores in bearing retainer (4) which must be clean.
4. Use a suitable driver and arbor press and install bearing cups (9 and 11) in retainer.
5. Apply engine lubricant on bearing assemblies; then set the retainer in place on bevel gear.
6. Install outer bearing cone (8), adjustment nut lock (6) and adjustment nut (3). NOTE: Care should be taken to prevent nut lock from turning with adjustment nut.
7. Support teeth of bevel gear in a soft jaw vice; then adjust gear bearing preload as follows:
   a. Wrap a heavy cord around bearing retainer and attach a spring scale as shown in figure 113.
   b. Use a deep spanner wrench to tighten bearing adjustment nut (3) to 175 to 200 foot-pounds torque. Rotate bearing retainer by pulling on spring scale. correct bearing preload will require a 4-1/2 to 9-1/2 lbs. pull to rotate retainer. If necessary, replace bearing adjustment spacer (10) with another size.

   Spacers of various sizes are available in thicknesses shown in chart at right.

   c. When correct adjustment is obtained, lock adjustment nut by bending up tab of adjustment nut lock (6).
8. Apply seal cement to outer diameter of seal (1), then press seal evenly into retainer.

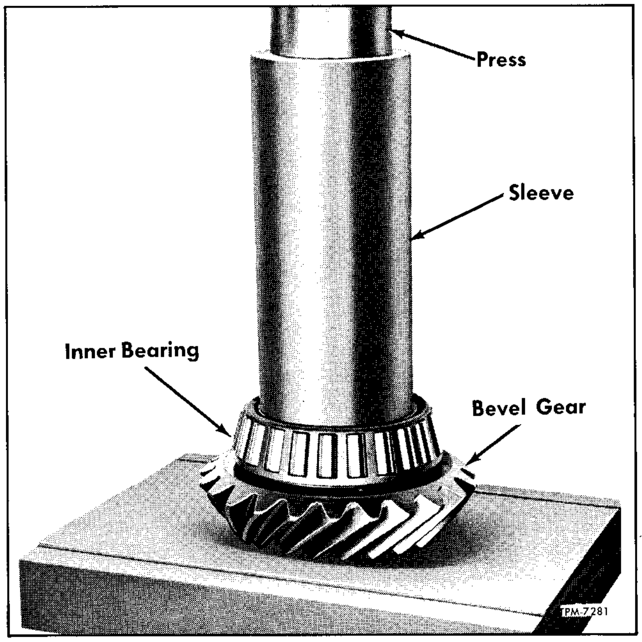


Figure 112—Installing Bevel Gear Inner Bearing

BEARING SPACER CHART

GM Part No.	Thickness	Stamped
2389880	.224"-.223"	P-24
2397019	.2225"-.2215"	P-225
2389879	.221"-.220"	P-21
2397018	.2195"-.2185"	P-195
2389878	.218"-.217"	P-18
2397017	.2165"-.2155"	P-165
2389877	.215"-.214"	P-15
2397016	.2135"-.2125"	P-135
2389876	.212"-.211"	P-12
2397015	.2105"-.2095"	P-105
2389875	.209"-.208"	P-09
2397014	.2075"-.2065"	P-075
2389874	.206"-.205"	P-06
2397013	.2045"-.2035"	P-045
2389873	.203"-.202"	P-03
2397012	.2015"-.2005"	P-015
2386043	.200"-.199"	P-00
2397011	.1985"-.1975"	P-985
2389872	.197"-.196"	P-97

9. Locate new O-ring seal (7) into groove of retainer (4). Assembly is now ready to install in housing.

BEVEL GEAR AND BEARING RETAINER INSTALLATION

NOTE: Key numbers in text refer to figure 111. To facilitate installation, the gear and retainer unit can be cooled and the accessory drive housing can be heated.

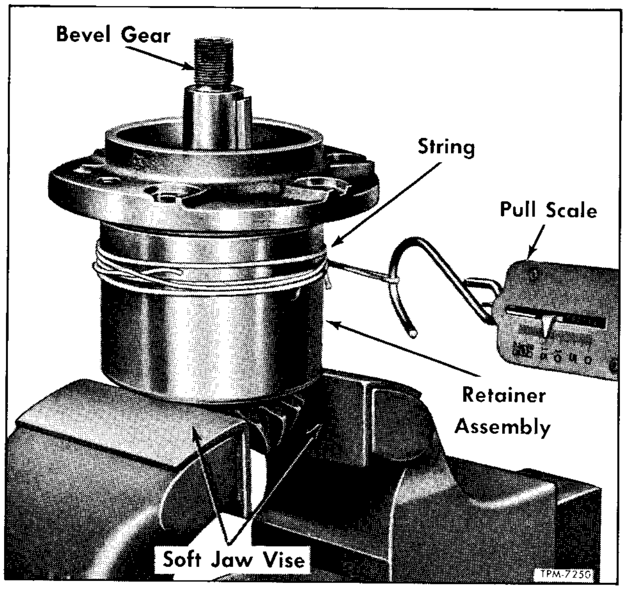


Figure 113—Checking Bevel Gear Adjustment

CAUTION

IF IT IS FOUND NECESSARY TO HEAT THE ACCESSORY DRIVE HOUSING, APPLY HEAT UNIFORMLY TO HOUSING, OTHERWISE THE CASTING MIGHT FRACTURE. HEAT LAMPS HAVE BEEN FOUND SATISFACTORY FOR THIS PURPOSE.

1. Apply clean (SAE #30) engine lubricant to outer surface of bearing retainer (4) and over O-ring (7) installed in groove of retainer.
2. Locate same pack of adjustment shims (5) removed originally over retainer (4), then with marks made on retainer and housing prior to disassembly aligned, insert bearing retainer into accessory drive housing (20).
3. Use two long bolts, opposing each other to pull retainer into housing, then install bolts and lock washers (2) attaching bearing retainer to accessory drive housing. Tighten bolts evenly and firmly.
4. Install propeller shaft flange with drive key to bevel gear. Coat flats of flange washer and face of flange nut with oil sealant, then install washer and nut. Tighten nut to 100 to 110 foot-pounds torque.

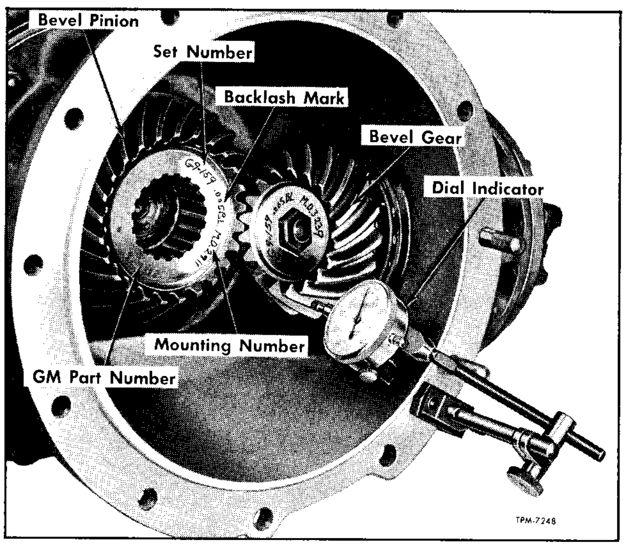


Figure 114—Checking Bevel Gear Backlash

BEVEL GEAR AND PINION ADJUSTMENTS

NOTE: Key numbers in text refer to figure 111.

Shims (5 and 19) are available in three thicknesses (0.003", 0.010", and 0.031") for adjustment of backlash and tooth contact of bevel pinion and bevel gear. Figure 115 shows shims installed between accessory drive housing and pinion gear retainer. Whenever assembling accessory drive unit or installing new pinion and bevel gear, or in event it should become necessary to readjust gear backlash because of normal wear, the following operations must be accomplished to properly adjust the pinion and bevel gear backlash.

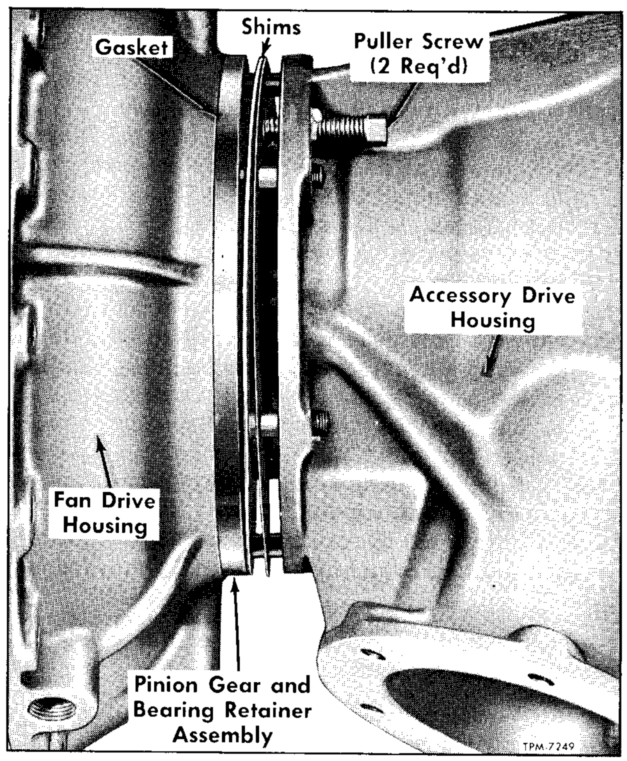


Figure 115—Shims Installed Between Accessory Drive Housing and Pinion Gear Retainer

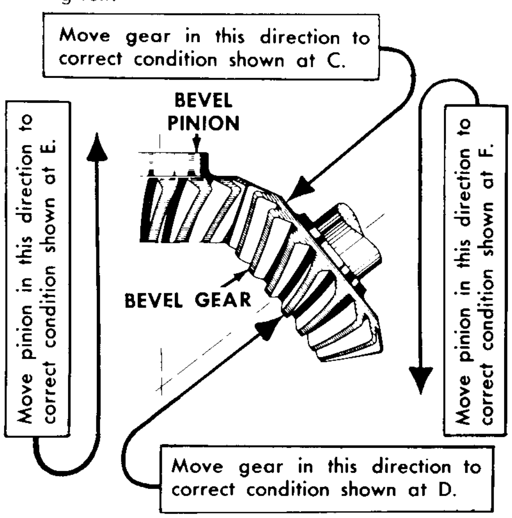
INSTRUCTIONS

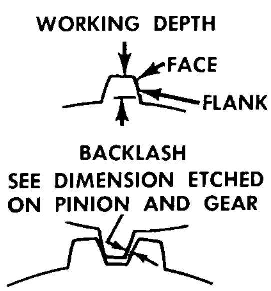
1—Install bevel pinion and bevel gear assemblies; then adjust pinion and bevel gear for proper backlash as directed in "Bevel Gear and Pinion Adjustments" paragraph of this section.

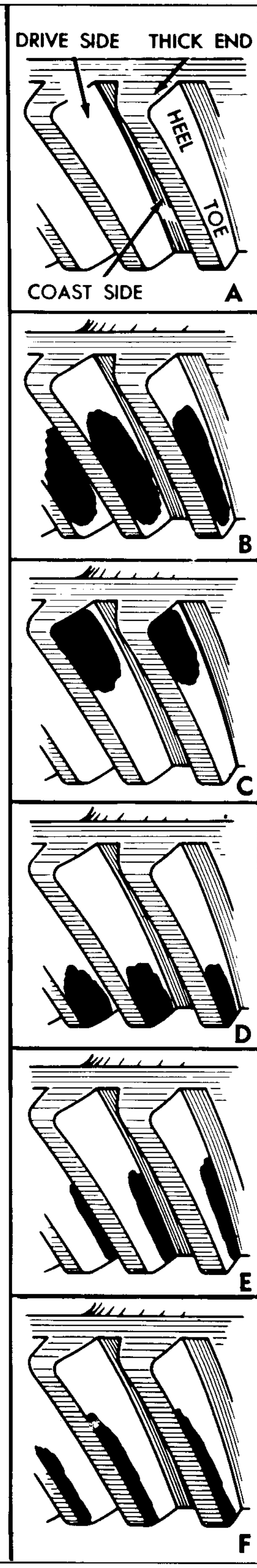
2—Paint three or four teeth of bevel gear with red lead or mechanics blue and rotate bevel gear in direction of rotation until pinion makes complete revolution.

3—Note area of tooth contact which should start at toe and extend about 80 percent of tooth length toward heel, as at B.

4—Vary position of pinion and gear as per chart until proper tooth contact is obtained. Be sure that sufficient backlash has been allowed so that gear can be completely revolved without any highspots being felt.







A—Check adjustments at drive side of BEVEL GEAR tooth

B—Shows correct tooth contact

NOTE: Key Numbers Below Refer to Figure 111.

C—Shows short contact at heel. To correct, decrease shim thickness (5) to move gear toward pinion. Then increase shim thickness (19) to move pinion away from gear to again secure correct backlash.

D—Shows short contact at toe. To correct, increase shim thickness (5) to move gear away from pinion. Then decrease shim thickness (19) to secure correct backlash.

E—Shows heavy contact on flank or lower portion of tooth. To correct, increase shim thickness (19) to move pinion away from gear until contact comes to full working depth of gear tooth without breaking contact at flank. Then decrease shim thickness (5) to move gear toward pinion to secure correct backlash.

F—Shows heavy contact on face or upper portion of tooth. To correct, decrease shim thickness (19) to move pinion toward gear until contact covers flank of tooth without breaking contact at face. Then increase shim thickness (5) to move gear away from pinion to secure correct backlash.

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Figure 116—Accessory Drive Bevel Gear and Pinion Tooth Contact Chart

SYSTEM MAINTENANCE

Backlash dimension is etched on pinion and bevel gear as shown in figure 114.

1. If accessory drive is installed to coach engine it must be removed as directed under "Cooling System" in current Diesel Engine Maintenance Manual.

2. Check gear backlash using dial indicator positioned as shown in figure 114. Dimension should be same as etched on gears. Adjustment can be accomplished through shims (5 and 19) provided between bevel gear bearing retainer (4) and accessory drive housing (20), and between bevel pinion bearing retainer (21) and accessory drive housing (20). Shims are of 0.003", 0.010" and 0.031" thickness.

3. To check for proper tooth contact, paint several teeth on pinion gear with a mixture of ground red lead and engine oil or a similar marking compound to provide a method of determining tooth contact.

4. Turn bevel pinion in direction of rotation (fig. 111) and observe tooth contact impression on drive side of gear teeth. Contact should start at toe of tooth (view B, fig. 116) and extend back about 80% of tooth length toward heel. Contact should be distributed evenly over flank and face of tooth, indicating center of contact on pitch line. Refer to views "A" and "B," figure 116.

a. If tooth contact is too far out on tooth toward heel (view C, fig. 116), decrease thickness of shim pack (5) between bevel gear bearing retainer (4) and accessory drive housing (20), moving bevel gear toward pinion. Restore backlash by increasing shim thickness (19) between pinion bearing retainer (21) and accessory drive housing (20). Figure 115 shows shims (19) installed between pinion gear bearing retainer and accessory drive housing. This view also shows puller screws used for removing bearing retainer from accessory drive housing.

b. If tooth contact extends from toe appreciably less than 80% of tooth contact (view D, fig. 116) move bevel gear away from pinion by increasing shim thickness (5) between bevel gear bearing retainer and accessory drive housing. Restore backlash by decreasing shim thickness (19) between pinion bearing retainer and accessory drive housing

c. If tooth contact is low on flank of tooth (view E, fig. 116), move pinion away from bevel gear by increasing shim thickness (19) between pinion bearing retainer and accessory drive housing. Restore backlash by decreasing shim thickness between bevel gear bearing retainer and accessory drive housing.

d. If contact is high on face of tooth (view F, fig. 116), move pinion toward bevel gear by decreasing shim thickness (19) between pinion bearing retainer and accessory drive housing. Restore backlash by increasing shim thickness (5) between bevel gear bearing retainer and accessory drive housing.

5. When pinion and bevel gear adjustments have been completed, make certain that all retainer attaching bolts (2) and nuts (16) are securely tightened. Recheck adjustment. Remove all red lead from gears.

6. Install accessory drive unit in coach.

For information on fan drive unit attached to end of accessory drive housing, refer to current Diesel Engine Maintenance Manual.

System Services and Tests

CONTENTS OF THIS SECTION

NOTE: General instructions for servicing air conditioning system are located on the back side of compressor compartment door as shown in figure 117. Detail service instructions are explained in this section under applicable headings.

CAUTION: ALWAYS WEAR SAFETY GLASSES WHEN HANDLING REFRIGERANT.

PREPARING SYSTEM FOR OPERATION

When air conditioning units have been inoperative during the off-season, certain inspection and service operations must be accomplished before system is placed back in operation.

1. If compressor has been overhauled, make sure proper amount of oil has been replaced in compressor.
2. Charge compressor with refrigerant to provide internal pressure. Refer to "Charging System" later in this section. Check for evidence of oil or refrigerant leakage past the compressor crankshaft seal using a leak detector. If seal leaks, remove compressor from coach and replace seal.
3. Replace filter element in condenser fan fluid reservoir, then refill reservoir to "OIL LEVEL" mark. Refer to "Condenser Fan Fluid Reservoir" previously for element replacement.
4. Remove air intake grille winter cover and shield from condenser compartment hood and cover (figs. 118 and 119).
5. Clean condenser coil as instructed later under "Cleaning Coils of Condenser."

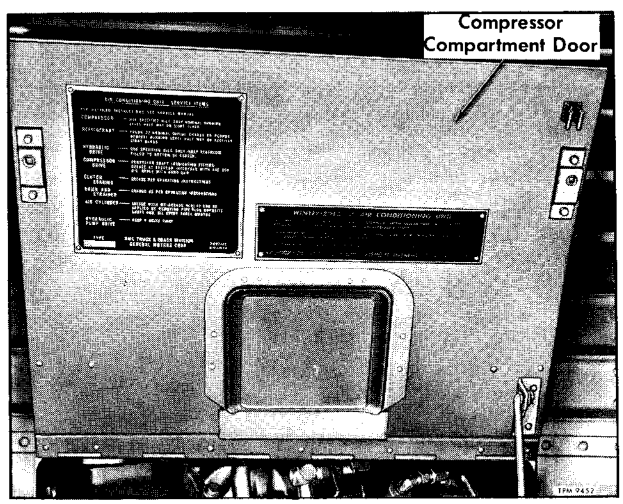

Figure 117—Air Conditioning Service Instruction Plates

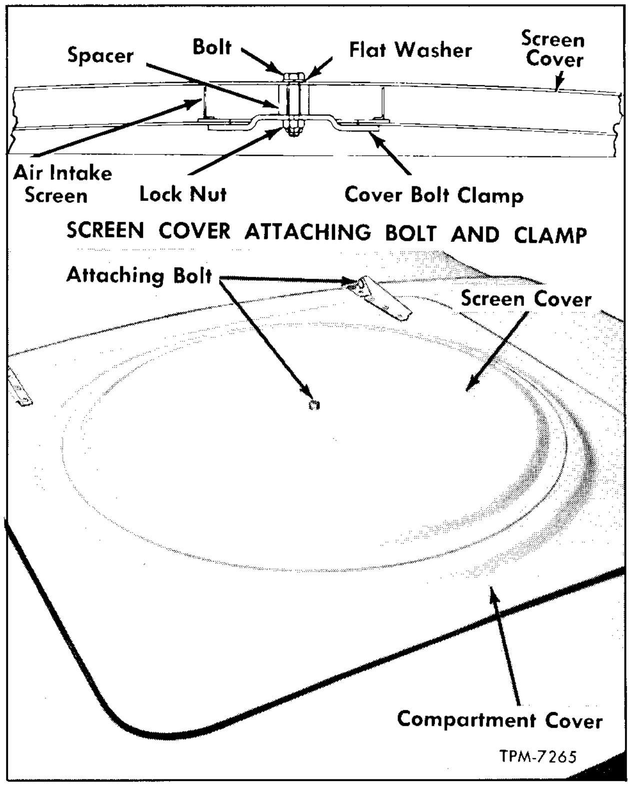

Figure 118—Winterization Top Cover Installed

6. Check tension of condenser fan fluid pump drive belts. Refer to "Condenser Fan and Drive" previously.

7. Clean air filter screens in heating and cooling compartment underneath coach. Also clean the evaporator coil in same compartment. Use high pressure water and air mixed being careful not to damage coil fins.

8. Connect feed wire to clutch control air solenoid valve (26, fig. 7).

9. Install new dehydrator-strainer unit in refrigerant system. Refer to "Replacing Dehydrator-Strainer" later.

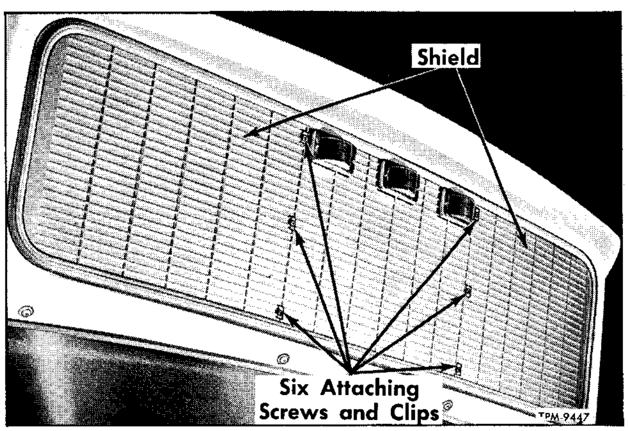

Figure 119—Winterization Rear Shield Installed

10. Place discharge and suction valves atop compressor in operating position as explained later under "Refrigerant Valves." Open receiver valves.

11. Lubricate compressor clutch mechanism as explained previously under "Compressor Drive."

12. Install compressor drive shaft assembly if previously removed or disconnected.

REPLACING CONDENSER FAN DRIVE PUMP BELTS

IMPORTANT: Do not attempt to replace only one or two belts. Replace the entire set. Belts are serviced in set of three.

NOTE: Pump drive belts can be replaced without having to remove compressor from coach.

BELT REMOVAL

1. Using run-up blocks or hoist, raise rear of coach to provide access from below compressor compartment.

2. Place engine control switches in engine compartment to "OFF" position.

3. Remove stone shield from below compressor and from under engine at left side.

4. Remove muffler assembly from engine compartment. This will provide access to compressor drive shaft.

5. Remove compressor drive shaft assembly. NOTE: If necessary to rotate shaft for access to flange bolts, turn engine crankshaft using a 1-1/2 inch socket wrench on lower camshaft pulley nut.

6. Spring-loaded clutch cylinder (2, fig. 95) must be disconnected from clutch release fork (8, fig. 95). In order to remove fork connecting pin (5, fig. 95), disconnect cylinder air line hose at air control solenoid valve, then apply shop air pressure through hose into air cylinder (min. air pressure required - 65 lbs.). This action will relieve pressure on cylinder yoke pin, allowing pin to be removed. Remove pin.

7. Remove condenser fan drive pump from compressor clutch housing as directed previously under "Fan Drive Pump Replacement."

8. Remove cover from access hole in coach floor above compressor. This will provide access to clutch housing upper attaching bolts.

9. Remove socket head bolts (13 and 14, fig. 95) which attach clutch housing to compressor. Using two of these screws installed into tapped holes, one at top, and bottom of housing, separate housing evenly from compressor. NOTE: On some early coaches, it may be necessary to remove radiator surge tank overflow line from opening in engine bulkhead before moving clutch housing rearward.

10. Referring to figure 120, move clutch housing rearward into propeller shaft opening in body bulkhead. With the aid of an assistant to retain housing in position, work one belt at a time over clutch flywheel and out of opening in housing as shown.

INSTALLATION OF BELTS

NOTE: Belts are serviced in set of three only and all three new belts should be installed. NEVER use new belts with old belts.

1. Referring to figure 120, insert one belt at a time into clutch housing opening and over clutch flywheel to pulley grooves.
2. Install clutch housing evenly to compressor using socket head bolts and special flat washers. NOTE: Install longer attaching bolt at location shown in figure 95. See item 14.
3. Apply shop air pressure to clutch control air cylinder, then install cylinder to release fork clevis pin, pin (washer) retainer, and rubber O-ring (5, 6, and 7, fig. 95). Attach cylinder air line to air control solenoid valve.
4. Install condenser fan drive pump and bracket assembly to clutch housing as directed previously under "Fan Drive Pump Replacement."
5. Install compressor drive shaft assembly.

IMPORTANT: Make sure the slip yoke end of shaft assembly is positioned toward the compressor. See figure 98.

6. Install muffler assembly.
7. Fasten stone shields under compressor and engine.
8. Place engine control switches in the engine compartment in operating positions.
9. Remove coach from run-up blocks or hoist.

PREPARATION OF SYSTEM FOR INACTIVE SEASON

1. The system should be pumped down and all refrigerant valves closed (two at receiver tank and two at top of compressor). Install protector cover and shield over condenser compartment openings. Figure 118 shows cover installed. Cover is retained with a bolt, spacer, clamp, and bolt nut. Hood rear shield is attached with six screws and clips (fig. 119).
2. In compressor compartment, disconnect #14 black with brown tracer wire from terminal of clutch control air solenoid valve (26, fig. 7). Tape terminal at end of wire.
3. The compressor drive shaft should also be removed from coach, or disconnected, to prevent wear to shaft universal joint bearings and to clutch shaft bearings.

Tag unit: CAUTION AGAINST STARTING.

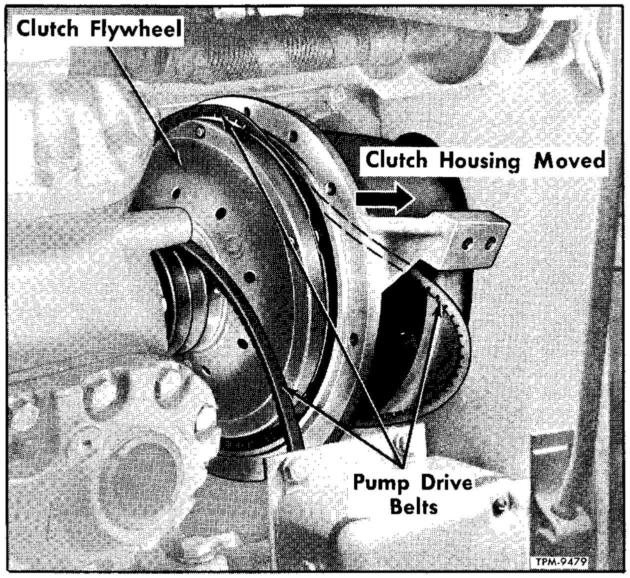

Figure 120—Replacing Condenser Fan Drive Pump Belts

SERVICING CONDENSER FAN DRIVE FLUID SYSTEM

DRAINING SYSTEM

1. Remove cover from fluid reservoir in condenser compartment at rear of coach.
2. With a catch basin positioned under line connections at fluid pump in compressor compartment, slowly break connections one at a time. Allow fluid to drain into basin.
3. After draining system, reconnect lines to pump. Tighten fittings to provide leakproof connections.

FLUSHING SYSTEM LINES

NOTE: Use a mixture of kerosene and air pressure to flush out lines.

1. Remove cover and filter element from fluid reservoir.
2. Disconnect all three lines at fluid pump and permit lines to drain into container.
3. Disconnect lines at fan motor and at fluid reservoir. Be careful to catch draining fluid.
4. Using a container at opposite end of lines, inject kerosene-air pressure mixture into all lines from condenser compartment. Final flush out lines using air pressure only. Clean out fluid reservoir also.

IMPORTANT: If residue from lines appear to be composed of deteriorated inner lining of line, replace line.

5. After flushing out lines, connect lines to units, then fill system to "OIL LEVEL" mark in reservoir.

SYSTEM SERVICES AND TESTS

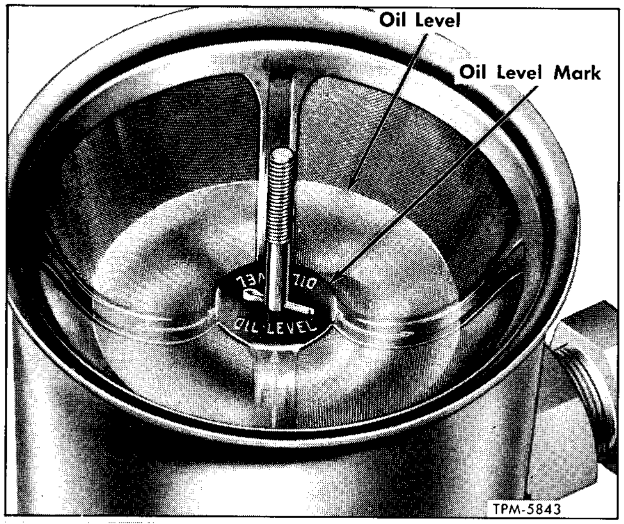

Figure 121—Oil Level in Condenser Fan Drive Fluid Reservoir

FILLING SYSTEM

1. Remove cover from system fluid reservoir in condenser compartment.
2. Fill reservoir with recommended fluid. System requires approximately five quarts.
3. Loosen return (IN) line connection at fluid pump so that this line will fill with fluid. Retighten connection when all air is expelled.
4. While having assistant maintain fluid level in reservoir, start engine and operate fluid pump. Run engine at fast idle speed while filling.

CAUTION: Do not operate engine without fluid in pump.

5. Make sure all air is expelled from system and reservoir is full to "OIL LEVEL" mark (fig. 121). Check for leaks at all line connections.

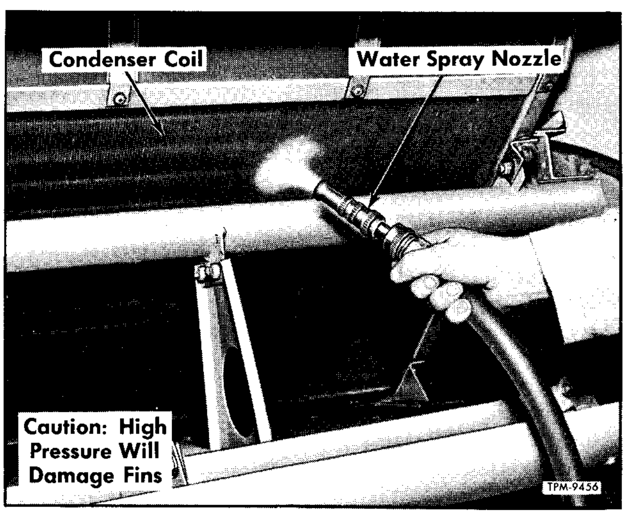

Figure 122—Cleaning Coils of Condenser

rubber seal at cover and the small rubber seal at cover nut are properly located. Tighten cover nut finger tight only.

REPLACING FILTER ELEMENT

Procedure for replacing reservoir filter element is explained previously under "Condenser Fan and Drive."

CLEANING COILS OF CONDENSER

IMPORTANT: During operating season, clean coils of condenser at weekly intervals or more often if operating under extreme dusty conditions. The importance of keeping the condenser clean cannot be over-emphasized as a clogged up condenser will cause high head pressure and will use up extra operating power.

A combination of water and air pressure blown through coils from the rear side (fig. 122) is satisfactory for loosening and removing dirt.

IMPORTANT: DIRECT PRESSURE STRAIGHT THROUGH COIL TO PREVENT BENDING OF FINS. ALSO, DO NOT USE EXTREME HIGH PRESSURE.

USING REFRIGERANT PRESSURE GAUGE SET

The gauge set shown in figure 123 is one tool that is definitely essential for servicing the air conditioning system. It is used for charging, evacuating and for diagnosing trouble in the system.

Gauge set can usually be obtained through a local refrigeration sales and service dealer.

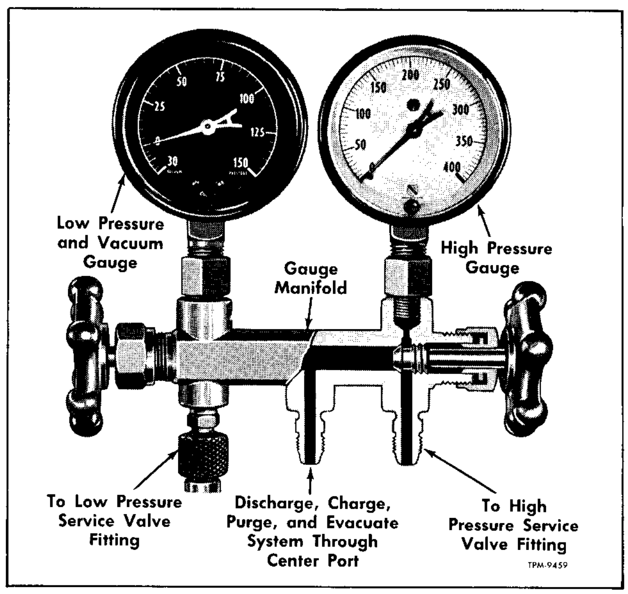

Figure 123—Refrigerant Pressure Gauge Set

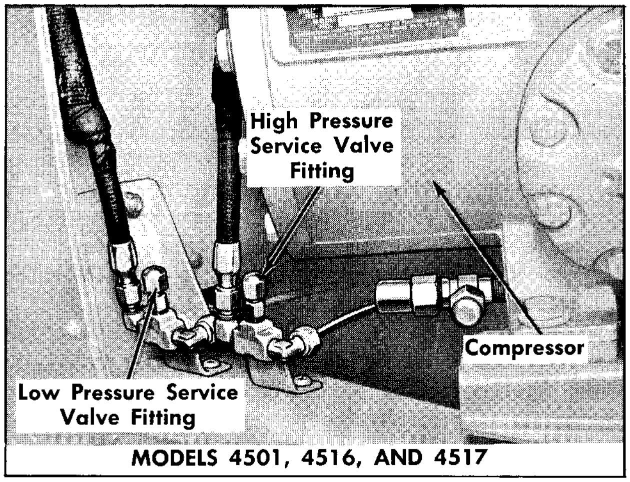

Figure 124—Refrigerant Service Fittings

The pressure gauge unit at the left side of set is the low pressure gauge with face graduated in pounds of pressure from 0 to 150 in 5 pound graduations; and, in the opposite direction, in inches of vacuum from 0 to 30 inches.

THIS GAUGE UNIT MUST ALWAYS BE USED IN CHECKING PRESSURE ON THE LOW PRESSURE SIDE OF SYSTEM.

NOTE: Figure 124 identifies high and low pressure service fittings in compressor compartment for the different coach models.

The pressure gauge unit at right side of set is the high pressure gauge with face graduated in pounds of pressure from 0 to 400 in 5 pound graduations.

THIS GAUGE UNIT SHOULD ALWAYS BE USED IN CHECKING PRESSURE ON THE HIGH PRESSURE SIDE OF SYSTEM.

Three lines at bottom of gauge manifold are for purposes explained in figure 123. NOTE: When center line is not being used, the connected line itself or the line fitting should be capped.

The hand shut-off valves do not have anything to do with opening or closing off pressure to the gauges. They merely close each opening to the center connector and to each other. During most diagnosing and service operations, the valves must be closed. The only occasion for opening both at the same time would be when evacuating the system.

IMPORTANT: When gauge set is being connected to system which is charged, the gauge lines MUST always be purged. Purging is done by "cracking" each valve on the gauge set to allow the pressure of system refrigerant to force air to escape through center manifold fitting. Failure to purge lines will result in air or other contaminants entering the system.

NOTE: To prevent gauges from getting out of calibration, handle carefully, and when not in use store gauge set in a safe place.

CHARGING THE SYSTEM

NOTE: Refrigerant in receiver tank should be to center of tank sight glass after system has been

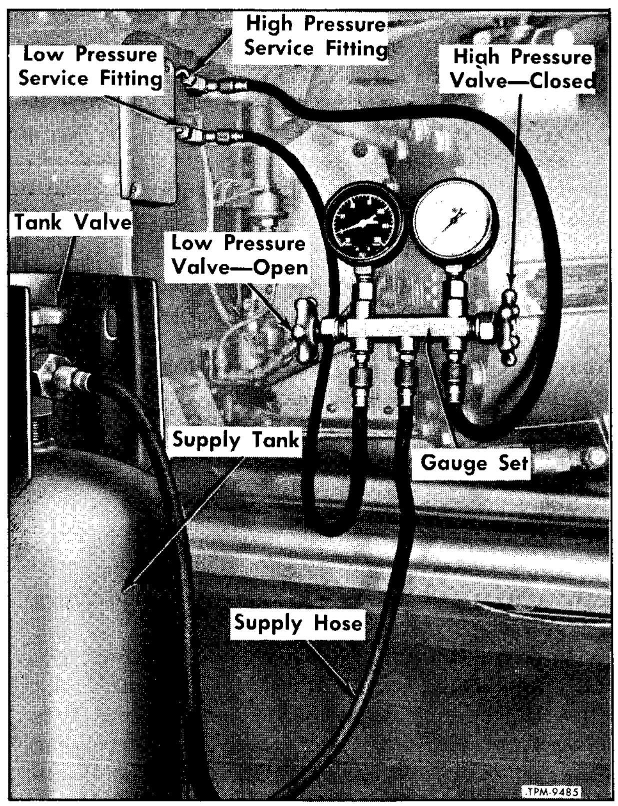

Figure 125—Charging System

in operation for 10 to 20 minutes at approximately 1500 engine rpm.

NOTE: Generally, refrigerant is admitted to the low pressure (suction) side of system in a gas state - refrigerant supply tank retained upright (fig. 125). Refrigerant which is admitted too fast into system may cause slugging in the compressor or it may cause the oil to leave the compressor.

ADDING REFRIGERANT TO SYSTEM

1. Connect refrigerant gauge set loosely to service fittings in the compressor compartment.

IMPORTANT: Make sure gauge lines are connected to respective high and low pressure service fittings. Fittings are identified for the different models on figure 124.

2. Connect the refrigerant supply tank line LOOSELY to center fitting of gauge set.

3. Purge air from tank supply line, then retighten line fitting. Leave supply tank valve open.

4. "Crack" open the shut-off valves of gauge set. This will purge air out of lines to service valves. Tighten line connections at service valves, then close shut-off valve at high pressure side of gauge set. NOTE: The high pressure line is hooked up and is purged of air but will not be used until system is charged and final check is made.

5. Have assistant start and operate system at approximately 1500 engine rpm. Open gauge low pressure valve. Refrigerant will be drawn into system through the low pressure side of system. DO NOT FEED REFRIGERANT TOO FAST AS THIS WILL CAUSE OIL TO LEAVE COMPRESSOR.

NOTE: If desired, charging can be speeded up by immersing supply tank in warm water - or by inverting the container. Again, caution should be taken about charging too fast.

6. Operate system until refrigerant level in receiver sight glass is at middle of glass. Coach temperature should be 85° to 90° F. during leveling off, so that all oil will return to compressor. Steam may be used for additional load on evaporator to hasten return of oil.

7. Close supply tank valve, then disconnect lines and remove gauge set. Install protector seals and caps to service fittings.

CHARGING AN EMPTY SYSTEM

IMPORTANT: The complete system should be thoroughly evacuated before adding refrigerant charge.

System can be charged in same manner as described above for "Adding Refrigerant to System." However, if compressor cannot be operated, refrigerant can be transferred from refrigerant supply tank to system by heating the supply tank, or by connecting tank to system immediately after evacuating, until refrigerant "HI-LO" pressure switch cuts in and compressor starts to operate.

REMOVING EXCESS REFRIGERANT

(Returning to Supply Tank)

NOTE: To avoid the possibility of removing compressor oil along with the refrigerant by exhausting the refrigerant at service fittings, it is recommended that the refrigerant be exhausted from the top of compressor suction valve. Do not operate system when removing refrigerant.

1. Back-seat suction valve by turning valve stem completely counterclockwise.

2. Remove small plug at stem end of suction valve, then connect refrigerant supply tank into plug opening. Hose should be connected loosely to empty or partially full supply tank.

3. Turn compressor suction valve stem clockwise five or more turns and purge air and moisture from hose connection at supply tank. After purging, tighten hose connection.

4. Pack refrigerant supply tank in ice or run cold water over tank until temperature of tank is reduced and pressure in tank is maintained well below the pressure in system.

5. Slowly open tank valve and permit refrigerant to enter tank. NOTE: The rate of refrigerant removal will be determined by the ambient temperature and by the coolness of refrigerant supply tank.

6. After short period of time, close tank shut-off valve, then start and operate system until it levels out. Observe refrigerant level on receiver tank sight glass which should be one-half way up on glass.

7. If necessary, repeat refrigerant removal procedure. NOTE: If too much refrigerant was removed, start up system, slowly open supply tank shut-off valve, then warm the supply tank. When refrigerant raises to center of receiver tank sight glass, close shut-off valve at top of supply tank, then back-seat the compressor valve.

8. Shut down the system. Disconnect supply hose from compressor and install small plug in top of valve. Leave valve stem in back-seated position. Install protector cap over valve stem.

NOTE: If desired, the system can be discharged completely by continuing step 5.

DISCHARGING THE SYSTEM

(To Atmosphere)

1. Back-seat the compressor discharge valve by turning valve stem completely counterclockwise.

2. Remove small plug at stem end of discharge valve, then connect a long hose into plug opening in valve. NOTE: If possible, place opposite end of hose at opening of an exhaust ventilating system. NEVER discharge refrigerant into closed area as possible suffocation could occur.

3. Crack open the discharge valve slightly

(turn stem clockwise) to allow refrigerant to discharge slowly. NOTE: If allowed to discharge rapidly, compressor oil may foam and be discharged also.

4. After discharging to proper level on receiver tank sight glass or discharging system completely, back-seat discharge valve, remove hose, install small plug in top of discharge valve, then install protector cap over valve stem.

5. If system was discharged completely, it can now be opened for parts replacement or any other reason.

EVACUATING THE SYSTEM

Whenever the refrigerant system has been opened to a point where air and moisture has been admitted, it is necessary to thoroughly evacuate the system before recharging. Air in system causes high head pressure and reduces cooling capacity. In case of emergency where a vacuum pump is not available, system may be blown out with refrigerant to eliminate air in system. This should only be done in case of emergency, since considerable refrigerant is used; also, a vacuum pump does a more satisfactory job.

NOTE: In case only a small portion of the system has been opened to atmosphere, that portion of the system may be blown out with refrigerant gas or evacuated as desired.

Any reliable refrigerant vacuum pump may be used. Evacuate the entire system as follows:

IMPORTANT: The system must be completely discharged before attempting to evacuate. See "Discharging the System" procedure.

1. Connect vacuum pump line to center fitting of refrigerant pressure gauge set, then connect the LOW PRESSURE - VACUUM side of gauge set to the high pressure service fitting in the compressor compartment.

IMPORTANT: Never attempt to evacuate through the high pressure side of gauge set, as the vacuum will seriously damage the high pressure gauge. Also make sure shut-off valve at this side of gauge set is closed completely.

NOTE: Figure 126 shows vacuum line (from gauge set) connected to the high pressure service fitting on models 5301 and 5302. Figure 124 will identify fittings on other models.

2. Tee a branch line with a wet bulb indicator into vacuum pump line as shown in upper view of figure 126.

NOTE: Wet bulb indicator can be improvised from a test tube, a short line, a rubber stopper, a narrow piece of felt (2 in. long) and an ordinary house thermometer.

3. Place all valves (two at receiver tank and two at the compressor) in operating position.

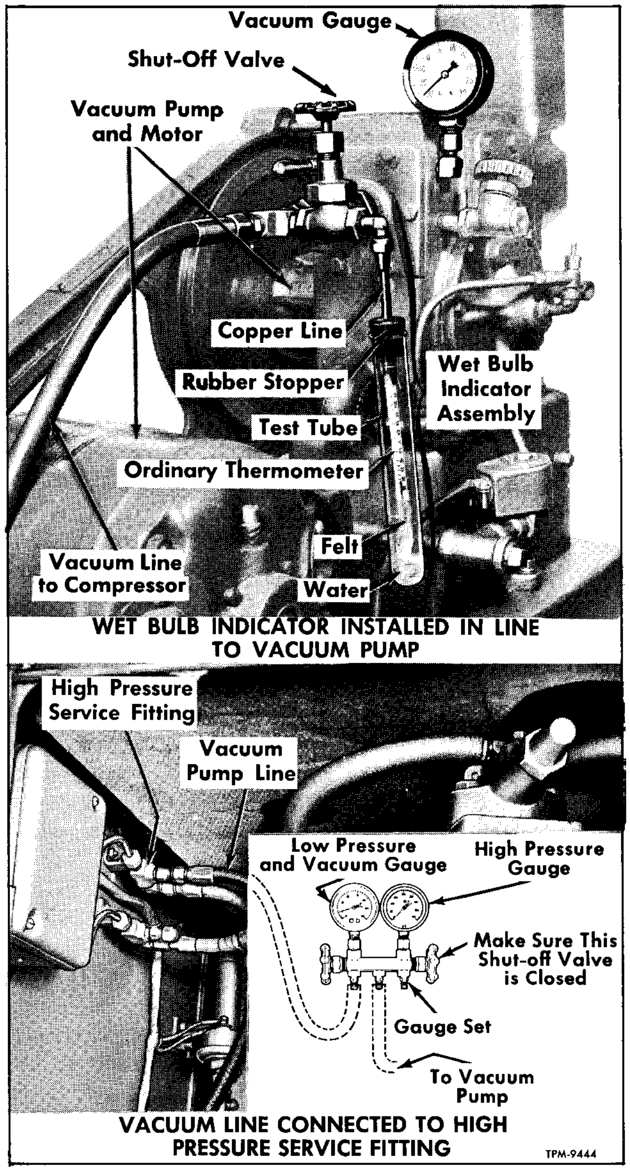

Figure 126—Evacuating the System

IMPORTANT: Before starting up vacuum pump make sure that seal and cap is tightened firmly over valve service fittings in compressor compartment that are not being used, otherwise outside air and moisture will be drawn into system. Figure 124 illustrates service fittings.

4. Operate vacuum pump to give maximum vacuum (28 in. min.) for at least two hours or until temperature reading on thermometer within pump indicator registers 35°F.

IMPORTANT: Open branch line-to-indicator valve only to read indicator. Otherwise keep valve closed during evacuating period.

5. Close the valve at the low pressure side of gauge set. Disconnect vacuum pump from center fitting of gauge set.

SYSTEM SERVICES AND TESTS

NOTE: Refrigerant charging supply tank (tipped upside down) can be immediately connected to center fitting of gauge set and several pounds of liquid refrigerant will be drawn into system when tank and low pressure gauge shut off valve are opened.

IMPORTANT: Supply tank connecting hose must be purged before gauge valve is opened.

6. Continue to completely charge the system as directed under "Charging the System" explained previously.

PUMPING DOWN THE SYSTEM

In order to accomplish any operations on the system which necessitate disconnecting refrigerant lines, it is necessary to first pump down the system to prevent appreciable loss of refrigerant. To pump down the system means to pump most of the refrigerant into the liquid receiver tank.

1. Connect a gauge set to low pressure test gauge service fitting in compressor compartment.
2. Operate compressor for 10 or 15 minutes to permit the system to level out, then with compressor still running, close the liquid out valve on top of liquid receiver tank by turning the valve stem in until the valve seats.
3. Continue to operate compressor at approximately 2000 engine rpm, until low pressure switch stops it, observing pressure on gauge.
4. When suction pressure builds up to low pressure switch cut-in (30 pounds - after approximately 5 minutes), again start compressor and run until it again cuts out.
5. Close receiver tank inlet valve and compressor valves immediately after system shuts off. Most of the refrigerant is now contained in the liquid receiver tank. A small amount of refrigerant in a gaseous state remains in compressor, condenser, and lines. Gas will be retained in compressor unless valves are opened. The small amount remaining in condenser and refrigerant lines will be lost when lines are disconnected.

IMPORTANT: If lines to be opened to atmosphere are colder than the ambient air temperature, a considerable amount of sweating will take place on inside of lines. Always allow refrigerant piping and units to warm up to the ambient air temperature before opening system.

CHECKING FOR AIR IN SYSTEM

Air in refrigerating system causes excessive head pressures and reduction in cooling capacity. Check for air in system as follows:

1. Connect an accurate pressure gauge to high pressure test gauge fitting.
2. Hang an accurate thermometer near condenser coil and one near receiver tank.
3. Allow compressor to stand idle for several hours to allow temperatures of all parts to equalize, then note readings on both thermometers and reading on gauge.
4. Take an average of the two thermometers and compare this figure with figures shown in pressure-temperature chart on page 415 in this manual. If pressure gauge shows a reading of more than 3 pounds higher than pressure shown on chart for the existing temperature, air must be purged from system.

PURGING AIR FROM SYSTEM

Whenever system has been pumped down or evacuated and system has been opened, or if operating difficulties indicate air in the system, purge air from system after all parts of system reach the same temperatures as follows:

1. Place refrigerant valves in "Operating Position" to admit refrigerant to entire system.
2. To purge air from liquid receiver tank, loosen fusible safety plug in top of receiver tank. Tighten plug after a small amount of refrigerant gas has escaped.
3. To purge evaporator, loosen external equalizer tube fitting at expansion valve, permit a small amount of gas to escape, then tighten fitting.
4. If a large amount of air is indicated, it may be necessary to pump the refrigerant into a refrigerant tank and purge the air from the tank. To accomplish this, connect line from refrigerant tank to high pressure test gauge (upper) fitting which connects to "HI-LO" pressure switch. While cooling refrigerant tank with cold water or ice, run compressor to pump the refrigerant into the tank. Continue to run compressor until low pressure switch stops it. As soon as compressor stops, close valve at refrigerant tank. Let tank stand for several hours, bleed air off top of tank, then transfer the refrigerant back into the system as directed previously under "Charging The System."

SUPERHEAT CHECK

Instructions for checking superheat are explained previously under "Expansion Valve" in "SYSTEM MAINTENANCE" section of this group.

TESTING FOR REFRIGERANT LEAKS

Whenever repairs or adjustments have been made to any part of the refrigerating system which necessitate disconnecting refrigerant lines, connections should be tested for leakage before the system is restored to service. First admit only enough gas into the system to produce 5 or 10 pounds pressure, then test for leaks (fig. 127), using leak detector explained below. If no leaks are found at this pressure, increase pressure 5 or

10 pounds, and test for leaks again. In this way, only a slight amount of refrigerant gas will be lost in the event there is a leak. Final test should be made with system under operating pressure. Large leaks will be indicated by oil seepage and must be repaired immediately.

REFRIGERANT LEAK DETECTOR

Refrigerant leak detector, commonly called a Halide Lamp, is a small torch which burns methyl alcohol. Air used in burner is drawn through a flexible sampling tube. Operation of leak detector is as follows:

Pressure is produced in the lamp fuel tank by heat of generation at time alcohol is burned in small cup under burner. Observe color of flame when clear air is being drawn through the sampling tube. Color of flame may vary depending on type and grade of alcohol used in burner.

By holding open end of sampling tube UNDER connections, joints, valves, etc. (fig. 127), any traces of refrigerant would be drawn through the tube to the burner and would be immediately evident by the change in color of the flame. Refrigerant breaks down when coming in contact with the heated copper ring in burner and changes the color of the flame. Do not confuse change in color with change caused by shutting off air supply in holding end of sampling tube too close to some object.

NOTE: Compressor crankshaft seal can be checked for leakage by inserting end of detector tube into hole at bottom of clutch housing when compressor is not operating.

> Instructions are supplied with leak detector and should be carefully studied. Only high grade Anhydrous Methyl Alcohol as listed under "Equipment and Material" at end of this group should be used in burner unless instructions state otherwise.

Leak detectors which burn acetylene gas are also available and may be used.

When refrigerant has been lost, adding refrigerant without knowing cause or location of leak merely postpones corrective measures and increases maintenance costs. At two or three week intervals, go over entire system with leak detector. Check for leaks at all joints and connections throughout the system.

REPLACING DEHYDRATOR—STRAINER

1. Pump down the system as explained previously.

2. Referring to figure 128, remove old unit in manner shown. CAUTION: Do not twist refrigerant lines; use two wrenches as shown.

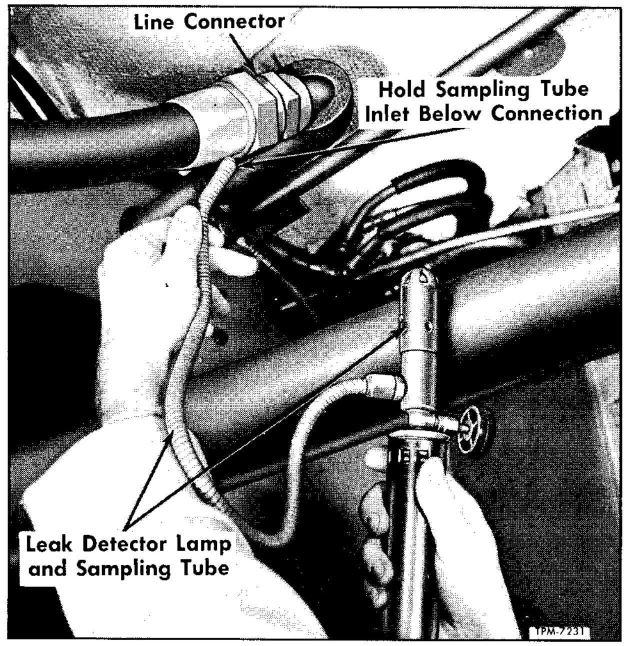

Figure 127—Testing for Refrigerant Leaks

3. Remove old unit from refrigerant line, then remove sealing caps from new unit and IMMEDIATELY thread unit into liquid line. Tighten connections firmly.

4. Open liquid receiver valves and compressor valves before placing the unit in operation. With system operating, test for leaks at connections, using a Halide Torch. Refer to "Testing For Leaks" explained previously.

REFRIGERANT VALVES

Before operating air conditioning system after storage or inactive period and during operation of

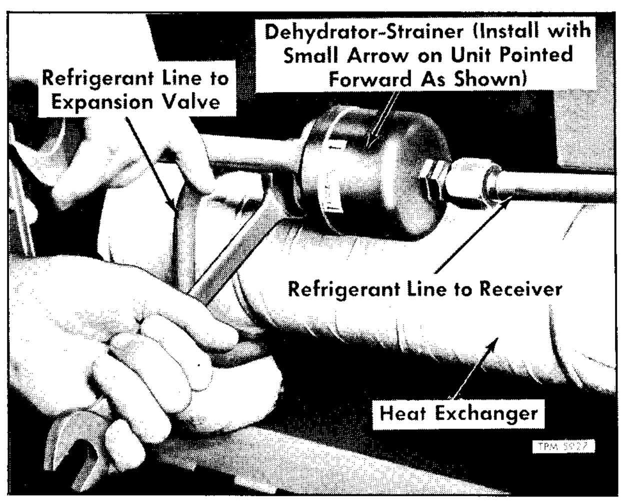

Figure 128—Replacing Dehydrator-Strainer

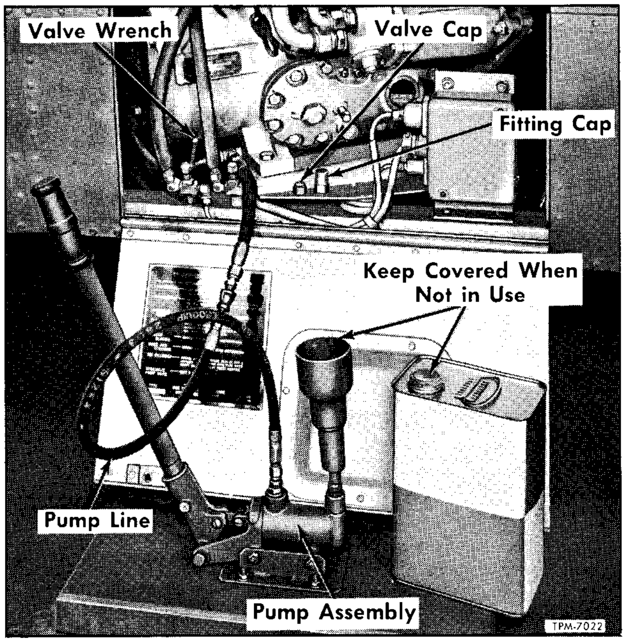

Figure 129—Adding Oil to Compressor (Typical)

system, refrigerant valves must be in "Operating Position." When system has been pumped down and is being prepared for operation, open valves in the following sequence:

1. Receiver Tank Liquid Out Valve - Fully

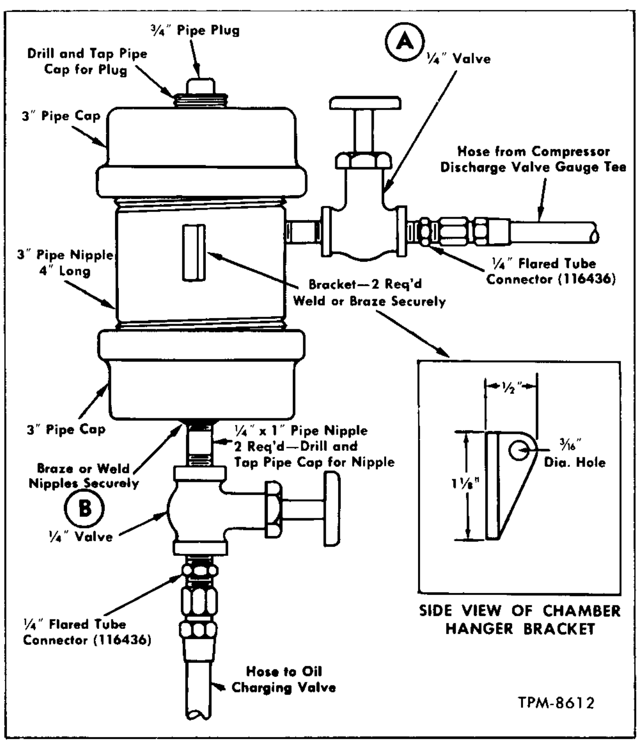

Figure 130—Fabricated Chamber for Adding Oil to Compressor

Open. Stem turned counterclockwise.

2. Compressor Suction Valve - Fully Open (Back Seated).

3. Compressor Discharge Valve - Fully Open (Back Seated).

4. Receiver Tank Inlet Valve - Fully Open.

SERVICING COMPRESSOR OIL CHARGE

The initial charge of oil in the compressor is 14 pints. Oil level in compressor is observed through sight glass at side of compressor. Oil level should be checked immediately after system has been in operation at approximately 1500 engine rpm for 45 to 60 minutes. Level should be 1/3 to 1/2 way up on sight glass.

If oil is to be added, use special wax-free dehydrated refrigerant type oil having a viscosity equivalent to SAE 10. This oil is readily available through major oil companies. Oil should be obtained in sealed cans. Never use oil which has been exposed to air for any length of time.

ADDING OIL TO A CHARGED SYSTEM

<u>Method Using Portable Hand Pump</u>

NOTE: Compressor oil is added to compressor by means of a pump connected to valve at bottom of compressor as shown in figure 129. Pump can usually be obtained from local refrigerant sales and service dealer. Another known source is Pulley Supply Co., Mail Order Div., Dept. MI, Glendale 1, California. Order by Part No. 1-HP3 Hand Pump and Handle.

With system leveled out (system operated for 45 to 60 minutes at approximately 1500 engine rpm) add oil as follows:

1. Stop compressor, then remove protector caps from valve stem and line fitting at bottom of compressor.

2. Connect pump supply line loosely to valve fitting. Fill reservoir of pump with recommended oil, then after all air bubbles have vanished, operate pump to purge air from line to compressor valve. Tighten connection at compressor valve.

3. Open compressor valve by turning stem counterclockwise.

4. Operate pump SLOWLY while checking oil level on compressor sight glass.

IMPORTANT: Keep pump reservoir near full at all times to prevent air from being pumped into system.

Add oil until level is 1/3 to 1/2 way up on sight glass. Close valve at base of compressor, then remove charging equipment.

5. Install protector caps over stem and line fitting of compressor valve.

Method Using Fabricated Oil Pressure Chamber

If a portable hand oil pump is not available, oil can be added with a pressure chamber as described below:

Figure 130 illustrates a chamber which can be fabricated locally using readily available parts. It is easy to visualize many other methods of constructing such a chamber, however, the general principles of the one shown in figure 130 should be followed.

Use chamber as follows:

1. Close both valves ("A" and "B," fig. 130) on oil chamber.

2. Fill the chamber with recommended oil. Hold chamber upright while filling. BE SURE CHAMBER IS COMPLETELY FILLED WITH OIL AND THAT NO AIR IS ENTRAPPED. Install filler plug and tighten firmly.

3. Connect a hose of sufficient length from upper valve (A," fig. 130) of oil chamber loosely to high pressure service fitting. Connect another hose from lower valve ("B," fig. 130) of oil chamber to oil charging valve at bottom of compressor.

NOTE: Before removing the cap from oil charging valve, make sure the valve is closed. Leave both hose connections loose at the oil chamber valves until air is purged from the hoses.

4. Tighten hose connection at high pressure service fitting and then at side of chamber after a slight amount of gas has escaped. Repeat this operation at the oil charging valve and hose. Leave the compressor oil charging valve in open position.

5. Start A/C system and operate until system has leveled out.

6. Open both shut-off valves ("A" and "B,"fig. 130) on pressure chamber, then watch oil level in compressor sight glass. When oil level is 1/3 to 1/2 way up on compressor sight glass, quickly close chamber valves. Close the oil charging valve at compressor and disconnect line quickly from the high pressure service fitting.

7. Disconnect hose from compressor oil charging valve. Install caps over fittings.

DRAINING EXCESS OIL FROM COMPRESSOR

NOTE: Compressor should be operated for at least 1/2 hour before draining to allow separation of oil and refrigerant.

1. Remove protector caps from stem and line fitting of valve located at bottom of compressor.

2. Connect flexible hose to valve fitting, then open valve slowly by turning stem counterclockwise. Allow oil to flow into suitable container.

NOTE: Special care should be taken when removing oil because of oil foaming. The foaming makes it difficult to determine the amount of oil being removed. Recheck compressor oil level. Close the valve and install protector caps after draining.

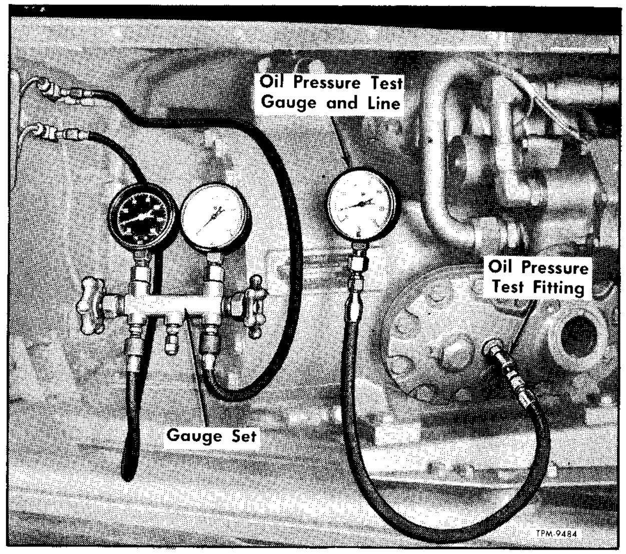

Figure 131—Checking Compressor Oil Pump Pressure

CHECKING COMPRESSOR OIL PRESSURE

To assure proper operation of the compressor unloading mechanism the compressor oil pump must supply the proper oil pressure. The compressor oil pump pressure check is made by subtracting the refrigerant suction pressure reading from the pump pressure reading. The minimum oil pressure reading allowable on pump gauge is 30 psi at 700 rpm engine speed.

Make Check as Follows:

1. Connect refrigerant pressure gauge set to low pressure gauge service fitting (fig. 131). See figure 124 which identifies fittings on the different models.

2. At side of compressor, install oil pressure gauge and hose to compressor oil pressure gauge fitting as shown.

3. Start engine and operate system for 5 to 20 minutes, then check refrigerant suction pressure reading and the pump pressure reading while system is still operating. If refrigerant suction reading is 55 and the oil pump pressure reading is 85, subtract 55 from 85 which leaves 30 psi, the actual pump pressure. If oil pump pressure is below minimum specified, replace compressor pump. The unloading mechanism will fail to function properly unless sufficient oil pressure is available.

CHECKING COMPRESSOR UNLOADING PRESSURES

Two cylinders of compressor are permanently loaded and two unload individually in two-pound steps when refrigerant suction pressure lowers to

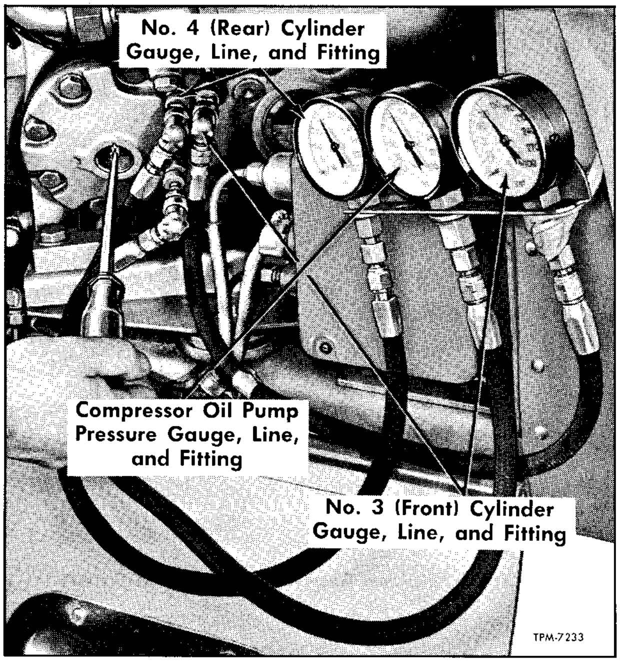

Figure 132—Checking Compressor Unloading Pressures

53 pounds. This function can be checked by observing suction pressure as follows:

1. Install test gauge low pressure line to low pressure test gauge service fitting (fig. 124).
2. Operate coach air conditioning system until reheat system is operating normally (approx. 75°F.)
3. With four cylinders loaded as engine speed is gradually increased, suction pressure should drop down to approximately 55 pounds, then fluctuate and raise to 58 pounds, indicating that No. 3 or front cylinder has unloaded.
4. As engine speed is increased further, suction pressure will lower to approximately 53 pounds and suction pressure will again raise rapidly as

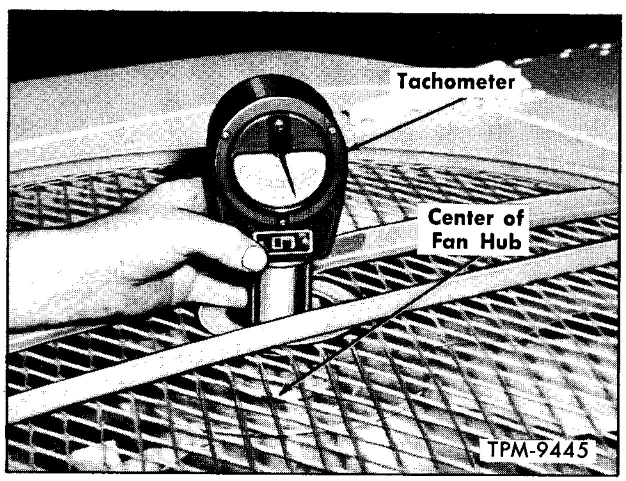

Figure 133—Checking Condenser Fan Speed

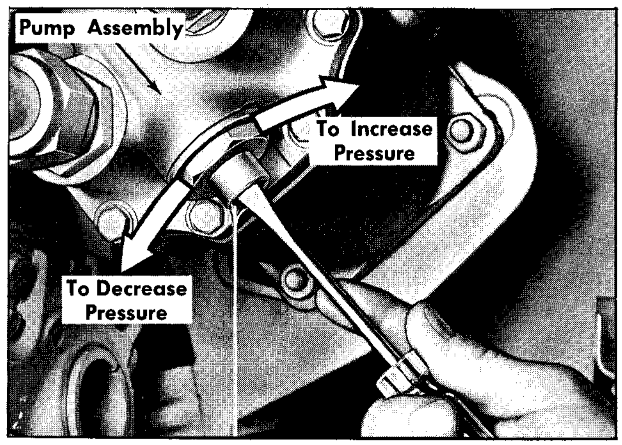

Figure 134—Adjusting Pump Pressure to Change Fan Speed

No. 4 or rear cylinder has unloaded. Further increase in engine speed will pull suction down. If unloading pressures are off, correction can be made by adjustment at valve located on compressor handhole cover. Make adjustment as follows:

a. Remove hex plug from over unloader adjustment screw as shown in figure 132.

b. Using screwdriver, turn screw out or counterclockwise to load up cylinders when they are running unloaded and lower suction pressure point at which cylinders unload. Thus, if all cylinders are loaded below 53 pounds suction, screw should be turned in to unload. If cylinders are unloading above 53 pounds suction, screw should be turned out to load. After making adjustment install hex plug over valve adjustment screw. Tighten plug firmly.

5. If difficulty is encountered in definitely observing unloading on suction gauge, individual gauges can be used to determine performance of each unloader without question. Figure 132 shows individual gauges installed.

a. Right gauge is connected to No. 3 cylinder unloader which unloads first. Left gauge is connected to No. 4 cylinder unloader which unloads last. The center gauge registers the compressor oil pump pressure. Gauges will indicate suction pressure plus oil pressure when cylinders are loaded and suction pressure only when unloaded.

b. Remove two adjacent 1/8 inch pipe plugs at top center of crankcase cover to install gauge lines.

CONDENSER FAN SPEED CHECK AND ADJUSTMENT

1. Using a tachometer (fig. 133) check speed of fan blade which should be 1800 ± 25 rpm when oil in system is hot and engine is at fast idle.
2. If not within speed tolerance, remove hex-head plug at pump relief valve, then quickly turn

adjustment screw in 3/4 turn for 100 rpm increase of fan speed, or turn screw out to decrease fan speed (fig. 134). NOTE A small amount of oil will be lost.

3. After specified speed is obtained, install hex-head plug firmly. Check, and if necessary, add oil to system.

CONDENSER FAN DRIVE PUMP PRESSURE CHECK

If necessary, pressure output of pump can be checked as follows:

1. Refer to figure 135 which shows test gauge installed in the high pressure hose to the condenser fan motor.
2. Disconnect high pressure hose at pump and quickly install improvised tee arrangement into circuit as shown. Connect test gauge and line to tee fitting.
3. Fill fluid reservoir to "OIL LEVEL" mark, then start system and observe pump pressure with engine operating at fast idle. Gauge should register approximately 980 psi after system has been in operation for a minute or two. Check fan speed which should be 1800 plus or minus 25 rpm.

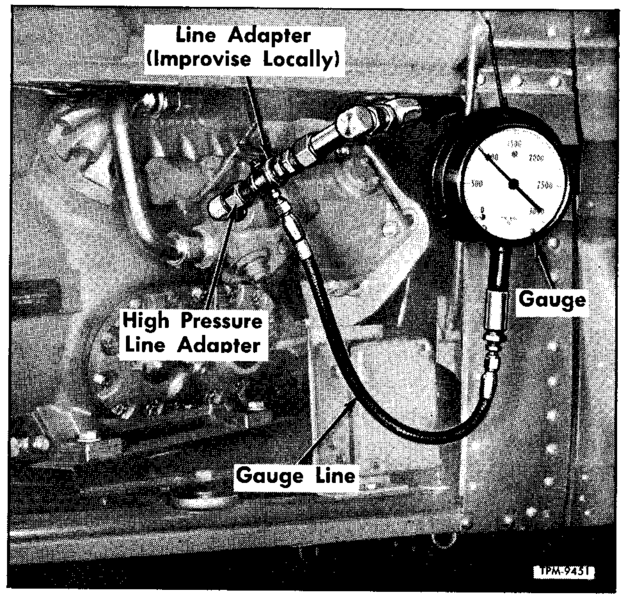

Figure 135—Checking Fan Drive Pump Pressure

Pressure can be changed by regulating the pump flow control valve as mentioned previously under "Condenser Fan Speed Check and Adjustment" (fig. 134).

Refer to next page for "Troubleshooting."

Trouble Shooting

Most any trouble in the air conditioning system will produce the same symptoms - insufficient cooling.

The following, which is more of a quick reference chart, deals with locating and correcting the common causes of insufficient cooling.

NOTE: Detail trouble shooting information of a specific condition, the possible causes of a condition, its symptoms and the recommended action to be taken is shown later on "Trouble Analysis Chart" page 493.

IMPORTANT

THE MOST COMMON CAUSE OF INSUFFICIENT COOLING IS A DIRTY, CLOGGED CONDENSER COIL. THIS CONDITION SHOULD BE CHECKED FREQUENTLY AND CORRECTED AS EXPLAINED ON PAGE 482.

CONDITION	REMARK
1. Underfloor Blower Not Running	
(a) Loose Electrical Connections	Tighten
(b) Defective Relay	Replace - Page 404
(c) Defective Blower Motor	Repair
2. Dehydrator - Strainer Clogged	Replace - Page 487
3. Underfloor Air Filter Screen Clogged	Page 416
4. Compressor Valves Not in Operating Position	Page 487
5. Improper Engine Idle Speed	Page 401
6. Low Refrigerant	
(a) Leaks in System	Page 486
(b) Recharge System	Page 483
7. Expansion Valve Inoperative	
(a) Capillary Tube Broken	Page 412
(b) Equalizer Tube Restricted	Page 412
(c) Gummed Cage	Page 412
(d) Check for Proper Superheat	Page 412
(e) System Short of Capacity	See "Trouble Analysis Chart"
8. Compressor Clutch Disengages or Fails to Engage	
(a) Dirty Condenser	Page 482
(b) Loose or Broken Condenser Fan Pump Belts	Page 423
(c) Insufficient Fluid in Condenser Fan Drive System	Page 424
(d) Too Much Refrigerant	Page 485
(e) Air in Refrigerant System	Page 486
(f) Insufficient Air Pressure for Clutch Operation	Page 462
(g) Air Leaks in Clutch Operating System	Page 462
(h) Worn Clutch Plates	Replace - Page 465
(j) Refrigerant Valves Not in Operating Position	Page 487
(k) Dehydrator-Strainer Plugged	Replace - Page 412
(l) Defective Clutch Control Air Cylinder	Page 471
(m) Defective Clutch Control Air Solenoid Valve	Page 410
(n) Faulty Clutch Adjustment	Page 462

9. Compressor Clutch Disengages or Fails to Engage at High Outside Temperatures (Items a, b, c, and e above will cause this condition.)

TROUBLE ANALYSIS CHART

This Trouble Analysis Chart is to supply information for trouble-shooting a specific condition, affected mostly by the operation of the refrigerant compressor. It also contains information on conditions affecting pressures within the refrigerant system.

CONDITIONS OR COMPLAINTS

> NOTE: Reference note numbers listed under each specific condition or complaint refer to information on the possible causes, the symptoms, and also recommendations for making correction. See designated notes below:

Compressor Fails to Start
(See NOTES: 1, 2, 3, 4, 5, 6 and 7)

Compressor "Short Cycles"
(See NOTES: 8, 9, 10, 11, 12, 13, 14 and 15)

Compressor Loses Oil
(See NOTES: 14, 16, 17, 18, 19, 20 and 21)

Compressor is Noisy
(See NOTES: 16, 19, 22, 23, 24, 25 and 26)

Refrigerant Discharge Pressure Too High
(See NOTES: 12, 15, and 30)

Refrigerant Discharge Pressure Too Low
(See NOTES: 13, 31, and 32)

Refrigerant Suction Pressure Too High
(See NOTES: 25, 32, 33, 34, 35 and 36)

Refrigerant Suction Pressure Too Low
(See NOTES: 11, 13, 14, 37, 38, and 39)

System Short of Capacity
(See NOTES: 11, 14, 25, 27, 28, and 29)

NOTES

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 1	Frozen compressor due to locked or damaged mechanism.	Compressor is noisy or will not operate.	Overhaul compressor.	See page 447
NOTE 2	Broken or sheared compressor drive shaft.	Excessive noise at engine or compressor not operating.	Repair or properly connect drive shaft.	See page 464
NOTE 3	Clutch drive plate is worn or saturated with grease.	Slipping action. Odor or smoke in compartment.	Replace clutch plate. Check and adjust clutch control air cylinder push rod travel.	See pages 462
NOTE 4	Defective clutch control air cylinder or improper linkage adjustment.	Slipping action. Odor or smoke in compartment.	Check and adjust air cylinder push rod travel.	See page 462
NOTE 5	Insufficient air pressure for clutch operation.	Slipping clutch. Odor or smoke in compartment.	Build up at least 65 psi in air system. Check pressure to air cylinder.	See page 462
NOTE 6	Defective clutch control air solenoid valve.	Clutch fails to engage.	Check for open circuit to valve. Loose connections. Defective valve.	See page 410

TROUBLE ANALYSIS CHART (CONT'D)

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 7	Open control circuit. a. Hi-Lo pressure switch defective. b. Engine oil pressure too high (over 15 psi). c. Engine idling too fast (above 600 rpm).	Open circuit to clutch solenoid valve.	Lower engine idling speed. Engine oil pressure must be below 15 psi. Oil may be cold. Check "HI-LO" pressure switch setting.	See page 401 See page 407
NOTE 8	Intermittent contact in electrical control circuit. Compressor valves not in operating position.	Compressor intermittently starts and stops.	Repair or replace faulty electrical control. Check for loose wiring connections. Open compressor valves.	See page 487
NOTE 9	Low pressure switch controller differential set to close.	Frequent starting and stopping.	Check Hi-Lo pressure switch setting.	See page 407
NOTE 10	High pressure switch controls differential too close.	Frequent starting and stopping.	Replace Hi-Lo pressure switch assembly.	See page 409
NOTE 11	Dirty or iced evaporator coil.	Reduced air flow: a. Dirty or clogged air filter screen. b. Underfloor blower inoperative. c. Plugged recirculating air ducts.	Clean air filter screen. Check recirculating ducts for obstructions. Check blower motor.	See page 416 See section 3
NOTE 12	Overcharge of refrigerant or noncondensible gas.	High discharge pressure	Remove excess refrigerant or purge system.	See page 485 See remark No. 7 later.
NOTE 13	Lack of refrigerant.	Too frequent starting and stopping on low pressure control switch.	Repair refrigerant leak and recharge system.	See remark No. 6 later.
NOTE 14	Clogged refrigerant dehydrator-strainer.	Suction pressure too low and frosting at strainer unit.	Replace dehydrator-strainer.	See page 487
NOTE 15	Faulty operation of refrigerant condensing system.	Compressor cuts off and on from high pressure switch. a. Condenser fan motor or pump inoperative. b. Condenser air inlet or exhaust grille obstructed. c. Condenser coil dirty.	Refer to "Condenser Fan Drive System Troubleshooting Chart." Remove obstruction. Clean coil.	See page 439 See page 482
NOTE 16	Insufficient oil.	Oil level too low.	Add proper amount of compressor oil.	See page 488

TROUBLE ANALYSIS CHART (CONT'D)

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 17	Traps in hot gas and suction lines.	Oil level gradually drops.	Recheck lines for possible traps. Lines may have been repositioned when body repairs were made.	See remarks Nos. 1 and 5 later.
NOTE 18	Loose expansion valve remote bulb.	Excessive cold suction line.	Provide good contact between remote bulb and suction line.	See remark No. 2.
NOTE 19	Liquid flooding back to compressor.	Excessive cold suction line. Noisy compressor operation.	Readjust superheat setting and check remote bulb contact.	See remarks Nos. 2 and 4 later.
NOTE 20	Short cycling.	Frequent starting and stopping of compressor.	See items previously under "Compressor Short Cycling."	
NOTE 21	Compressor leaking oil.	Oil around base and low oil level on sight glass.	Repair oil leak and add proper refrigerant oil.	See page 488 and 66
NOTE 22	Loose compressor drive shaft.	Flange nuts loose.	Tighten bolt nuts.	See page 464
NOTE 23	Dry or scored compressor crankshaft seal.	Squeak or squeal when compressor is running.	Check oil level. Replace compressor seal.	See page 488
NOTE 24	Internal parts of compressor broken.	Noisy compressor.	Overhaul compressor.	See page 447
NOTE 25	Expansion valve stuck in open position.	Abnormal cold suction line. Compressor knocks.	Repair or replace expansion valve.	See remark No. 2 later. See page 15
NOTE 26	Compressor hold-down mountings loose.	Compressor vibrates excessively.	Tighten or replace mountings.	See page 447
NOTE 27	Flash gas in liquid line.	Expansion valve hisses.	Add refrigerant.	See remark No. 6 later.
NOTE 28	Excessive pressure drop in evaporation.	Superheat too high.	Check superheat and reset expansion valve.	See remark No. 4 later.
NOTE 29	Improper superheat adjustment.	Short cycling.	Adjust expansion valve.	See remark No. 4 later.
NOTE 30	Air or non-condensible gas in system.	Exceptionally hot condenser and excessive discharge pressure.	Purge system.	See remark No. 8 later.
NOTE 31	Broken or leaky discharge valves within compressor.	Suction pressure rises faster than 5 lbs. per minute after pressure shut-down.	Remove compressor head, examine valves and if necessary, replace.	See remark No. 9 later.

TROUBLE ANALYSIS CHART (CONT'D)

	Possible Cause	Symptoms	Recommendations	Reference
NOTE 32	Leaky relief valve in compressor.	Insufficient cooling.	Replace relief valve.	See page 37
NOTE 33	Excessive load on evaporator.	Insufficient cooling.	Check for leaks in evaporator compartment. Check air filter screen and blower motor.	
NOTE 34	Overfeeding of expansion valve.	Abnormally cold suction line. Liquid flooding back to compressor.	Check contact of expansion valve remote bulb in suction line well.	See remarks Nos. 4 and 5 later.
NOTE 35	Broken suction valves within compressor.	Noisy compressor.	Remove compressor head, examine valves and if necessary, replace.	See remark No. 9 later.
NOTE 36	Compressor worn.	Insufficient cooling.	Overhaul compressor.	See page 447
NOTE 37	Expansion valve power unit has lost charge.	No flow of refrigerant through valve.	Replace expansion valve assembly.	See remark No. 3 later.
NOTE 38	Obstructed expansion valve.	Loss of capacity.	Clean or replace expansion valve.	See page 412
NOTE 39	Too much pressure drop through evaporator coil.	Superheat too high.	Check for plugged external equalizer line at expansion valve.	See page 412

TROUBLE ANALYSIS CHART REMARKS

REMARK
NO. 1 - CLOGGED REFRIGERANT DEHYDRATOR-STRAINER (Refer to Fig. 15)

Occasionally the dehydrator-strainer in the liquid line may become clogged with foreign material in the system. When this happens, the liquid line leaving the strainer will feel cooler than the liquid entering. If it is badly clogged, some sweat or frost may appear at strainer outlet.

REMARK
NO. 2 - REFRIGERANT EXPANSION VALVE STUCK IN OPEN POSITION (Refer to Figs. 16, 18, and 19)

If the expansion valve is stuck in an open position, there will be an excessive amount of sweating on the suction line and compressor crankcase due to the large amount of liquid being passed into the suction line.

REMARK
NO. 3 - REFRIGERANT EXPANSION VALVE HAS LOST CHARGE (Refer to Figs. 16, 18, and 19)

The power element of expansion valve consists of the remote bulb, capillary tube and the diaphragm, which actuates the valve cage. If this power element is inoperative or has lost its charge, the valve will either maintain an almost closed position or may close completely. Test for an inoperative power element as follows:

a. Stop compressor.
b. Remove remote bulb from well in suction line at end of evaporator coil.
c. Carefully place remote bulb in container filled with ice water.
d. Start compressor.
e. Remove remote bulb from ice water and warm in hand. At the same time check suction line for rapid temperature change which indicates flood-through of liquid refrigerant. If refrigerant floods through valve, power unit is operating properly.

WARNING: Do not flood-back through suction line for too long a period as excessive liquid flood back could cause severe damage to compressor.

TROUBLE ANALYSIS CHART REMARKS (CONT'D)

REMARK
NO. 4 - REFRIGERANT EXPANSION VALVE IMPROPERLY ADJUSTED (Figs. 16, 18, and 19)

If the expansion valve is adjusted for too low a superheat, too much liquid will be passed into evaporator. The suction line will be normally cold and liquid may slug back to the compressor. If expansion valve is adjusted for too high a superheat, too little liquid will be passed to the evaporator and the suction line will be abnormally warm. Superheat must always be adjusted carefully using thermometer (fig. 19) and suction gauge.

REMARK
NO. 5 - REFRIGERANT EXPANSION VALVE IS OBSTRUCTED (Refer to Figs. 16 and 18)

Foreign material may obstruct the valve port. If the obstruction is small, the resulting operation will be a "hunting" condition which will cause a suction pressure variation of possibly 10 to 15 psi on suction pressure test gauge. If the obstruction is large and only a small trickle of liquid can pass, the compressor will short cycle. If the obstruction holds the valve open during shutdown, liquid will flood back to compressor. This causes liquid slugging to compressor at start-up, which is definitely harmful. Compressor will knock when this occurs. An obstructed expansion valve is usually indicated by a partly warm evaporator and frosting at the evaporator inlet.

REMARK
NO. 6 - SHORTAGE OF REFRIGERANT

There should always be sufficient liquid in the receiver tank (1/2 way up on sight glass) to completely submerge the inlet to the liquid line pipe. If there is a shortage of refrigerant, the liquid level will fall below the inlet to the liquid line and a mixture of gas and liquid will pass into the liquid line. Bubbles will appear in the sight glass, the larger the bubbles the more severe the refrigerant shortage. Frequently there will be a hissing or whistle at the expansion valve. The coil and suction line will be relatively warm while the suction pressure will be low due to little or no liquid being supplied to the evaporator if the shortage is severe.

REMARK
NO. 7 - OVERCHARGE OF REFRIGERANT

An overcharge of refrigerant will cause high head pressure. Liquid will back up in the condenser and decrease the amount of surface available for condensing and as a result the head pressure will rise. In extreme cases, it may rise to a point where the high pressure cut-out switch will stop the compressor. This may result in compressor short cycling.

REMARK
NO. 8 - AIR IN SYSTEM, PURGING

If air or non-condensible gases are present in the system, they will usually tend to move toward and collect at the condenser. The head pressure will rise to a point above the pressure corresponding to the temperature at which the vapor is condensing. In extreme cases, the pressure may rise to a point where high pressure cut-out switch will stop the compressor.

To determine whether or not there is air in the system, the compressor must be allowed to stand idle long enough for the entire system to cool down to the temperature of the surrounding air. After the system has attained the same temperature as the surrounding air, the reading of the head pressure test gauge should not be more than 12 lbs. above the saturation pressure corresponding to the surrounding air temperature. See "Refrigerant, Pressure-Temperature Relationship" chart, page 415.

REMARK
NO. 9 - BROKEN VALVES IN COMPRESSOR

Broken suction valves or broken or leaky discharge valves within the compressor are generally indicated by the suction pressure rising rapidly as soon as the compressor is stopped. If the suction pressure rises faster than 5 lbs. per minute, it is an indication that the compressor discharge valves are not holding. Before the compressor is torn down, however, it should be determined that the pressure rise is not due to a leaky expansion valve.

Air Cond. Lubrication and Inspection

The following tabulation lists lubrication and service points, service required, and the recommended intervals at which these services should be accomplished. These services should be accomplished at more frequent intervals when system is operated under severe conditions such as extremely high temperatures. References in right-hand column refer to page numbers where service procedures are covered, or to Lubrication Notes below for recommended lubricant and proper application.

Item	Service Required	Daily	At Inspection	See Footnote	Refer to
Compressor	Check Oil Level - Add if Required	X			Page 488 (Note 1 below)
	Drain and Refill			(A)	--
	Check Tightness of Mounting Bolts		X		--
Compressor Suction and Discharge Valves	Check Tightness of Mounting Bolts and Valve Caps		X		--
Liquid Receiver Tank	Check Refrigerant Level	X			Page 484
	Check Tightness of Mounting Bolts		X		--
Condenser	Clean Coils as Necessary	X			Page 482
Condenser Fan Drive Pump Belts	Check Belt Tension		X		Page 423
Dehydrator Strainer	Replace Cartridge			(B)	Page 488
Underfloor Air Filter Screens	Clean and Re-oil		X		(Note 2 below)
Evaporator Coil	Clean		X		Page 416
Hi-Lo Pressure Switch	Check Adjustment		X		Page 407
Driver's Control Panel	Tighten Connections		X		--
Condenser Fan Fluid Drive	Check Oil Level - Add if Required		X		Page 481 (Note 3 below)
Compressor Drive Propeller Shaft	Lubricate with Hand Gun		X		(Note 4 below)

(A) After initial 200 hours of operation. (B) Whenever system has been opened.

NOTE 1—COMPRESSOR OIL

A special wax-free dehydrated refrigerant type oil having a viscosity about the equivalent of S.A.E. 10 must be used. This oil is readily available through major oil companies. Approved oils are: Texaco Capella D; Ansul 300 non-foaming; Std. Oil of Calif., Caloil 13W. Oil should be obtained in sealed cans. Never use bulk oil or oil which has been exposed to air for any length of time. Drain and refill after first 200 hours of operation. After this change only at overhauls. The compressor capacity is 14 pints.

NOTE 2—ODORLESS OIL

Air Filter Screens. Thoroughly clean filter screens, then spray, or dip and let drain, with light odorless oil, such as medicinal white oil.

NOTE 3—HYDRAULIC FLUID

Condenser Fan Drive System. Use Type "A" Automatic Transmission Fluid bearing the qualification letters "AQ-ATF." System capacity is 5 quarts. IMPORTANT: Keep fluid container covered while not in use.

NOTE 4—GEAR OIL

Compressor Drive Shaft Universal Joints. Apply small quantity of gear oil (S.A.E. 140) to three fittings (fig. 98) at coach regular lubrication intervals.

Equipment and Materials

The following equipment and materials are required for servicing the Air Conditioning System. This equipment and material can be procured locally or from any reliable air conditioning or refrigeration supply house.

EQUIPMENT

Thermometer with Remote Reading Dial - For use in conjunction with expansion valve adjustment.

Soldering Torch and Cylinder of Gas - For soldering refrigerant line fittings.

Oil Pressure Gauge - For checking compressor oil pump pressure.

Leak Detector - For detecting refrigerant leaks.

Vacuum Pump and Gauge - For evacuating the system. Should be capable of pulling 28 to 29 inches of mercury vacuum.

Test Gauge Fitting Hose Adapters - For adapting service refrigerant hoses to gauge fittings (J-9459 Adapter and J-12148 Adapter Gasket).

Wet Bulb Indicator - For checking amount of air and moisture in system while evacuating system.

Hand Oil Pump - For adding oil to a charged system.

Pressure and Vacuum Gauge Set - For checking Refrigerant-22 system operation.

- With combination vacuum air pressure gauge
  - 0 to 30" vacuum scale.
  - 0 to 150 lbs. pressure scale.
- With high pressure gauge - 0 to 400 lbs. scale.

MATERIALS

Anhydrous Methyl Alcohol - For use in leak detector.

Refrigerant 22 - Monochlorodifluoromethane. Do not use any other type of refrigerant in this system. (Approximately 60 lbs. required in system, available in 22 lb. cans.)

Solder - 95% tin and 5% antimony - For soldering refrigerant line fittings.

Nokorode Soldering Paste - For use on soldered fittings.

Specifications

AIR CONDITIONING REFRIGERANT CONTROL SPECIFICATIONS

COMPRESSOR

Make	Trane
Model	3B-5C40
Trane Part No.	Com-143
GM Part No.	2386650
Rated Capacity at 2000 RPM	
Maximum Head Pressure	425 psi (gauge)
Suction Pressure	10-45 psi (gauge)
Initial Oil Charge	14 pts.

DEHYDRATOR-STRAINER

Type	Disposal

EXPANSION VALVE

Make	Alco Valve Co.
Adjustment	External
Setting	8^{o} - 14^{o} Superheat

HI-LO PRESSURE CUT-OUT SWITCH

Make	Penn. Electric Switch Co.
Type	1277MP12
Model	1502
High Pressure Switch	
Opens at	375 psi (gauge)
Closes at	175 psi (gauge)
Low Pressure Switch	
Opens at	10 psi (gauge)
Closes at	30 psi (gauge)

AIR CONDITIONING MISCELLANEOUS SPECIFICATIONS

CONDENSER FAN DRIVE
System Hydraulic Fluid Capacity (Approx.). . 5 qts.
Fan Motor Speed (At 1650 Engine RPM
- With Hot Oil) . . . . 1775 to 1825 rpm

Fluid Pump Assembly
GM Part No. 2392520
Make . . . . Sundstrand Machine Tool Co.
Model No. 32PVS6LT-402-5

Fan Motor Assembly
GM Part No. 2372644
Make . . . . Sundstrand Machine Tool Co.
Model No. 7MCSL-403-3
H.P. Rating . . . . Approx. 3

Fluid Reservoir Assembly
GM Part No. 2372643
Make . . . . Sundstrand Machine Tool Co.
Model No. 30RFS-100-1

AIR CONDITIONING CONTROL RELAY
Make . . . . Delco-Remy
Stamped 1116899
Air Gap (With points closed) . . . . 0.014"
Point Opening . . . . 0.028"
Closing Voltage Range 8.5-10.5
Opening Voltage . . . . 4.3 min.

CLUTCH CONTROL AIR CYLINDER
GM Part No. 2389497
Make . . . . Midland-Ross
Stamped N-3858
Stroke . . . . 1.120"

COMPRESSOR DRIVE CLUTCH
Clutch Size . . . . 9-1/8"
Type . . . . Single Plate, Dry Disc
Release Bearing Type . . . . Sealed-Ball

AIR CONDITIONING ENGINE
OIL PRESSURE SWITCH
Make . . . . AC
Stamped 1509175
Contact Break Pressure . . . . 15 ± 2 psi

AIR CONDITIONING CLUTCH
CONTROL AIR PRESSURE SWITCH
Make . . . . AC
Stamped 1508844
Contact Closing Pressure . . . . 65 psi

ACCESSORY DRIVE GEAR RATIO
All V-6 Engine Models . . . . 1.388 to 1
All V-8 Engine Models . . . . 1.588 to 1

REFRIGERANT COMPRESSOR WEAR RATE CHART

Part Name	Original Spec.	Recommended Limit	Maximum Recommended Oil Clearance
Main Bearings	1.8765 - 1.8775	1.8800	
Crank Shaft - Mains	1.8745 - 1.8750	1.8730	0.0055
Conrod - Crankpin (Vert.)	1.7522 - 1.7530	1.7560	
Crankshaft - Crankpin . .	1.7495 - 1.7500	1.7470	0.0070
Piston Pin	.7498 - .7500	0.7494	
Piston - Pin Bore	.7499 - .7502	0.7504	
Conrod - Pin Bore (Vert.).	.75005 - .7503	0.7505	0.0011
Cylinder Liner	2.5000 - 2.5005	2.5020	
Piston (Perpendicular to Centerline of Pin Bore) .	2.4985 - 2.4990	2.4970	0.0035
Piston Rings (Gap in . . . . 2.500" Gauge)	.007 - .017	(.040 Compression Rings (.060 Oil Rings	
Valves (All)	Valves are .028" - .030" thick - if not broken, valves should be replaced when seat groove wear depth exceeds .010". (.018" thinnest section).		
Valve Springs (All)	Whenever compressor is disassembled for servicing, valve springs should be replaced where they have operated in excess of 3000 hours.		

Special Tools

References are made to special tools in some sections of this manual. These tools, or their equivalent, are necessary and are recommended to readily and efficiently accomplish certain service operations. These tools, however, are not supplied by GMC Truck & Coach Division. Information regarding availability of these tools can be obtained from your GM Coach Service Representative or from the Factory. Following is a list of all special tools referred to throughout the manual.

SECTION 2 - REAR AXLE

J-8176	Bearing Puller Set
J-3940	Bearing Cup Remover
J-4856	Differential Bearing Remover Plug

SECTION 3 - BODY

J-2189	Glass Seal and Insert Installer
80-0202	Heater Water Pump Remover

SECTION 4 - BRAKES

AIR BRAKES

CVT-8	Valve Reseating Tool (Expello Valve)
CVT-7	Valve Stem Service Fixture (Expello Valve)

ROTARY AIR COMPRESSOR

AL51	Bearing Guide Sleeve
AL52	Arbor (for replacing bearings)
AL53	Burnishing Bar
AL74	Spanner Wrench

SECTION 7 - ELECTRICAL

1568147	Electric Speedometer Test Light
J-6663	T-3 Headlight Safety Aimer

SECTION 14 - AIR SUSPENSION

J-6888	Valve Core Remover and Installer (Height Control Valve)
J-8424	Overtravel Control Shaft Remover and Installer (Height Control Valve)

SECTION 16 - STEERING

MECHANICAL STEERING

J-544-01	Spring Scale
J-489	Bearing Puller
J-21143	Pitman Arm Puller
J-3187-A	Side Cover Bearing Puller
J-2619	Slide Hammer (Use with J-3187-A)
J-5529	Pitman Shaft Bearing Remover and Installer
J-8176	Bearing Remover Plates

POWER STEERING

J-5631-01	Pressure Checking Gauge

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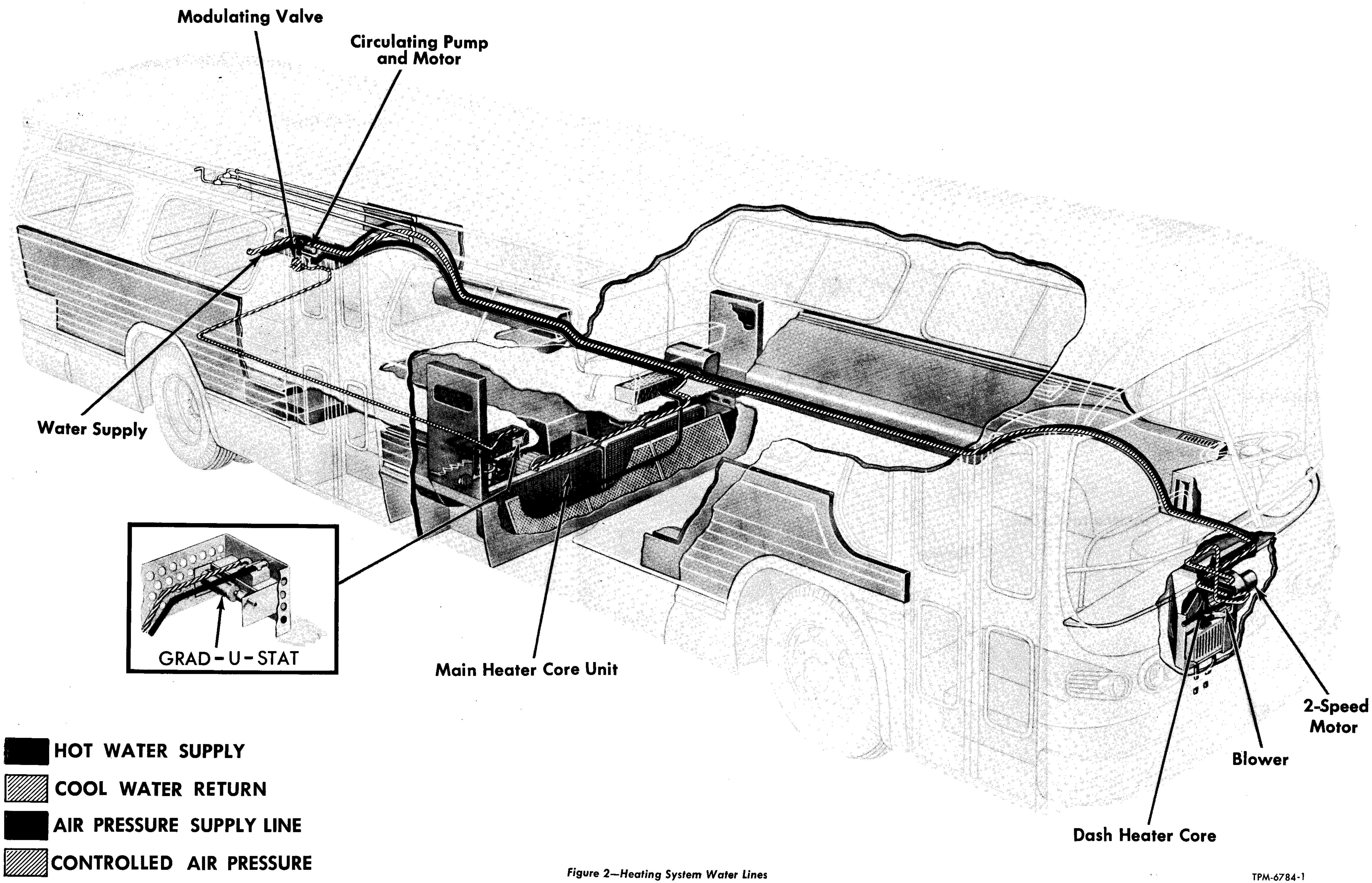

Figure 2—Heating System Water Lines

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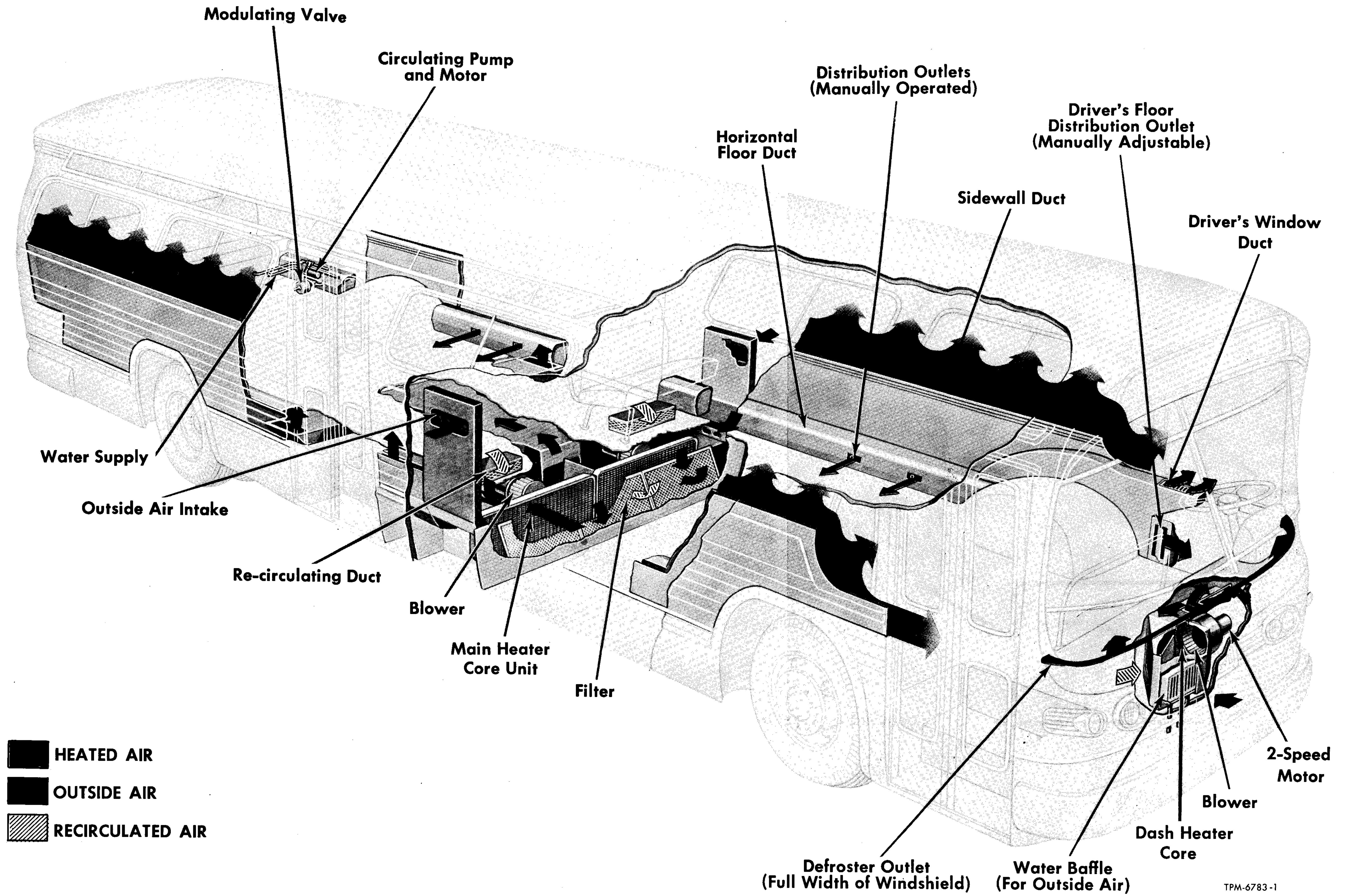
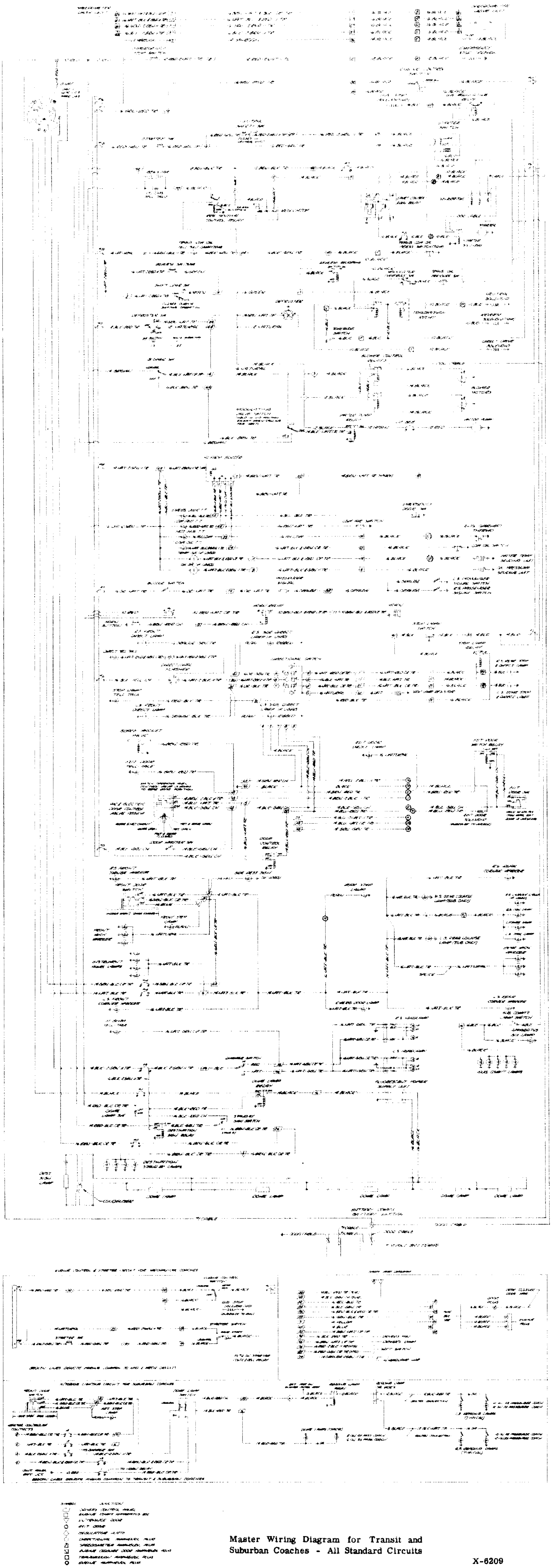
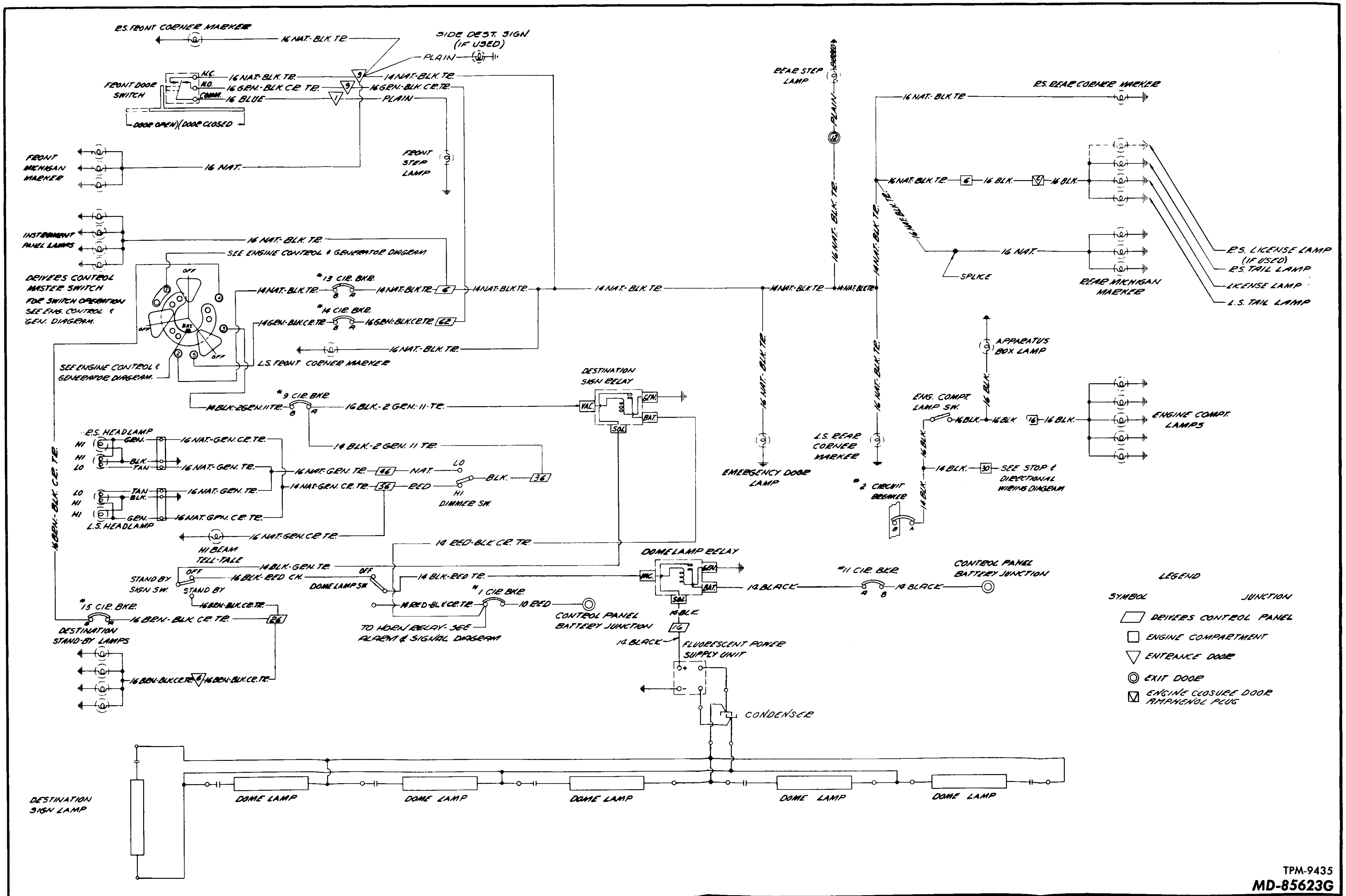


Figure 3—Heating System Air Flow

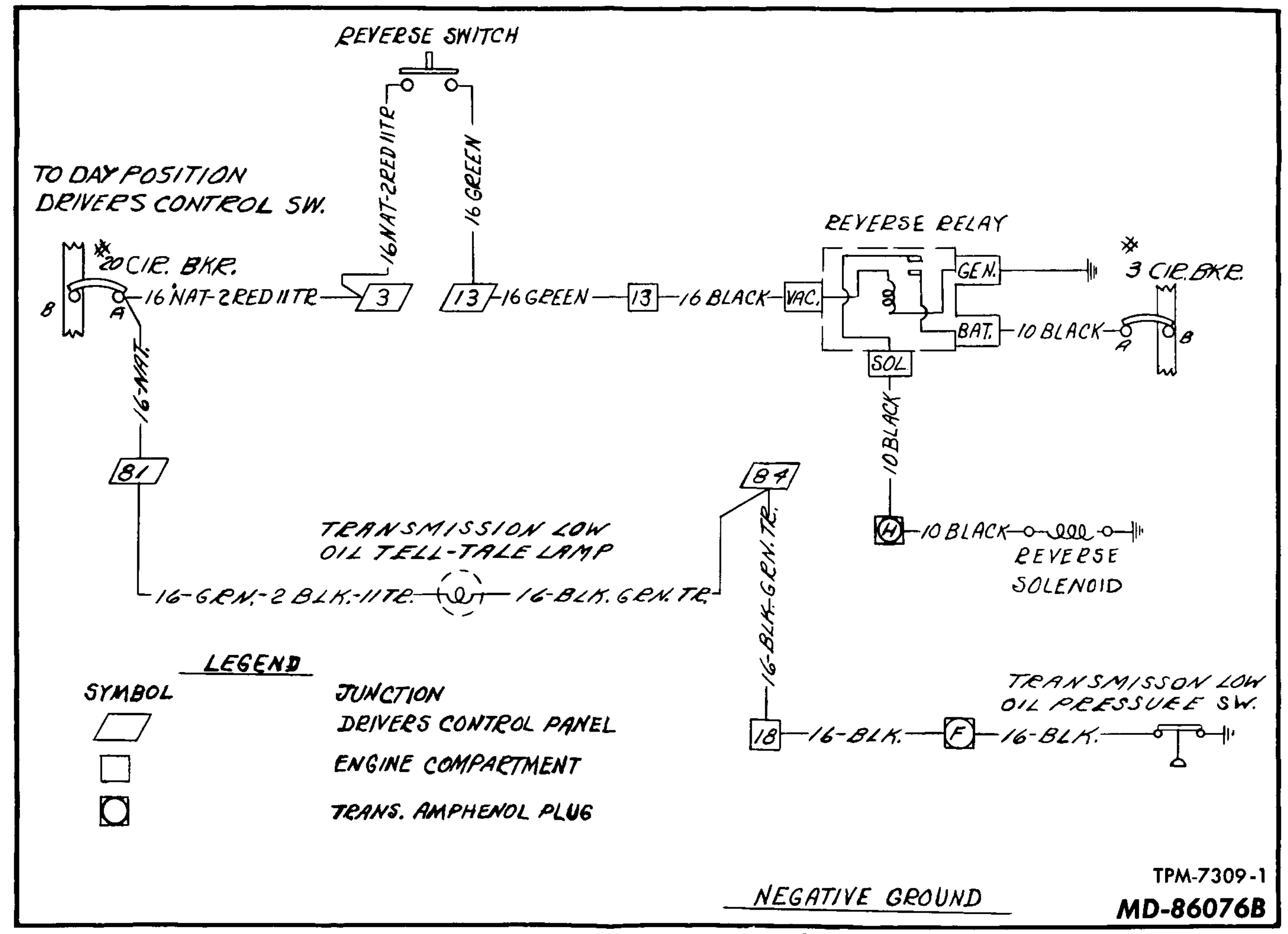


Master Wiring Diagram for Transit and Suburban Coaches - All Standard Circuits

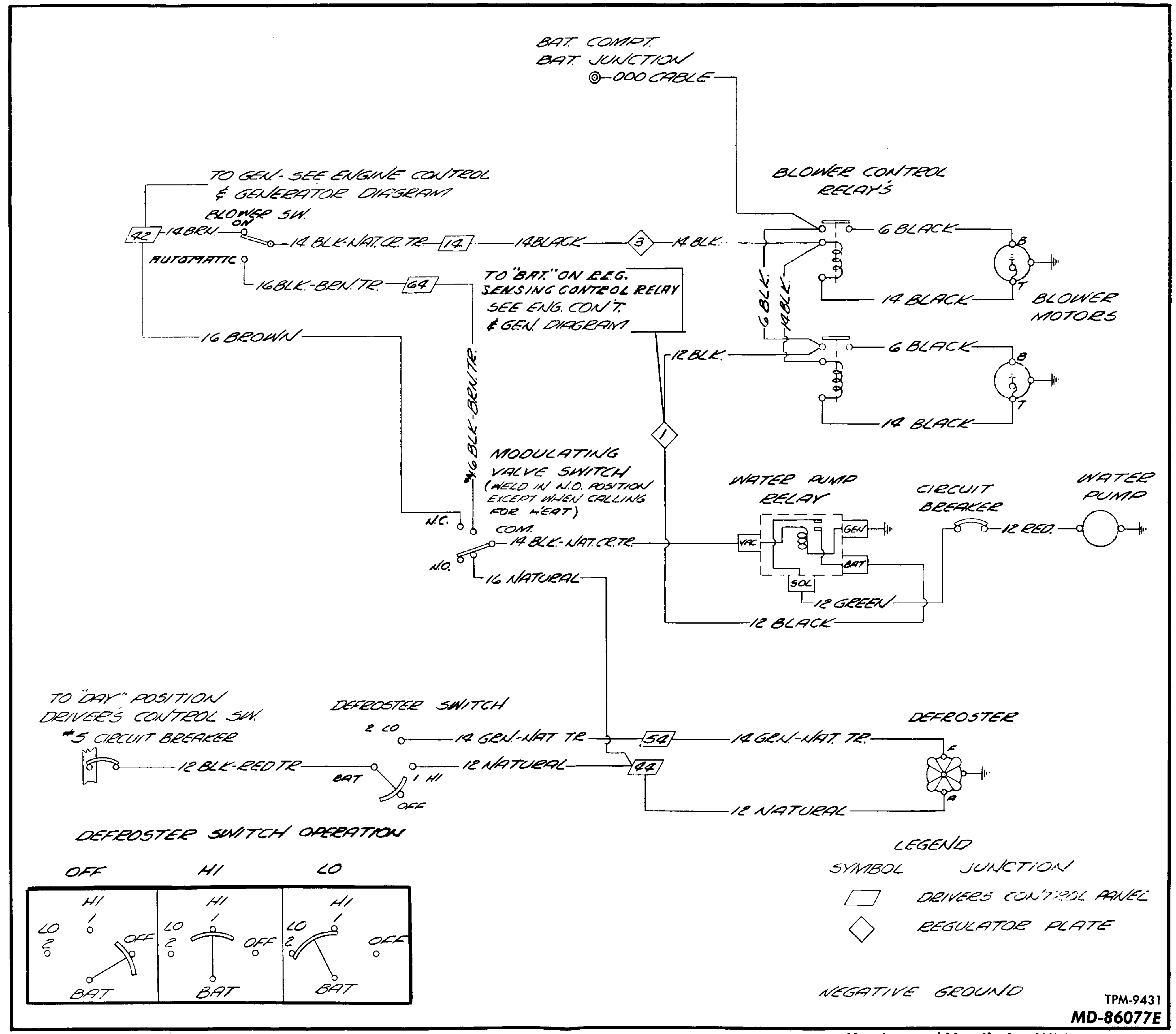
X-6209



Lighting System Wiring Diagram—TDH and TDM



Mechanical Transmission Wiring Diagram



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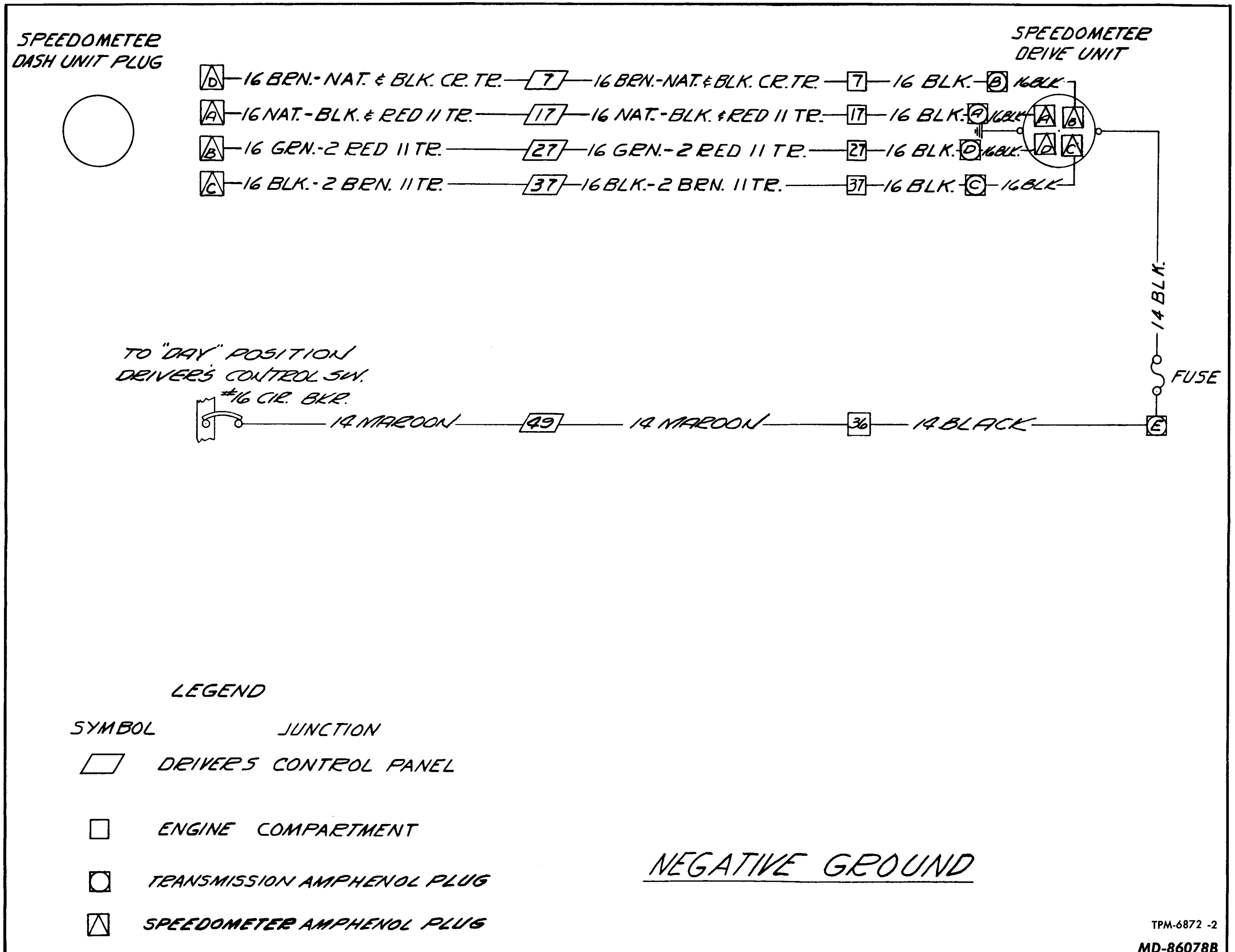
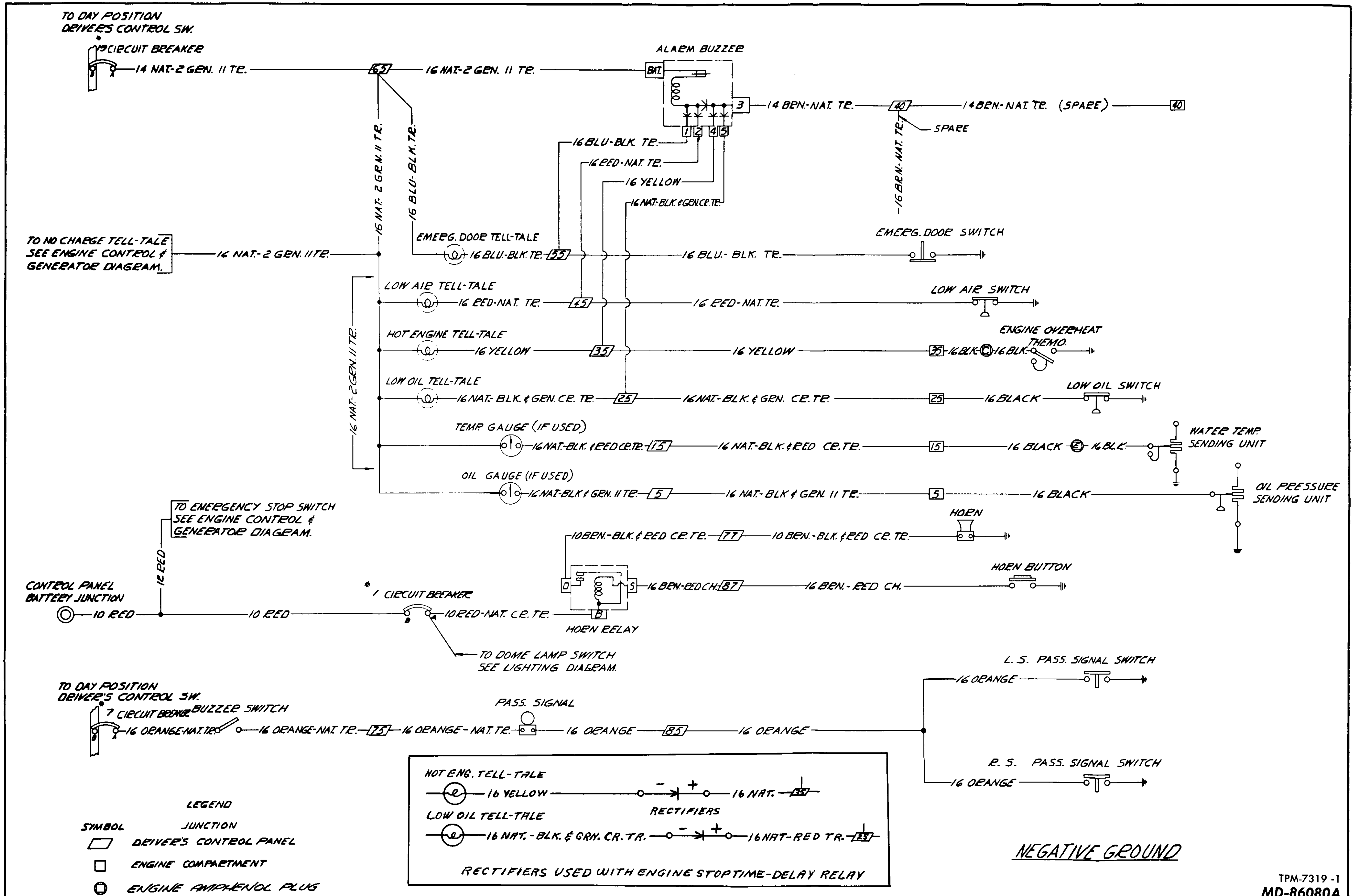
Heating and Ventilation Wiring Diagram



MD-86078B

Speedometer Wiring Diagram



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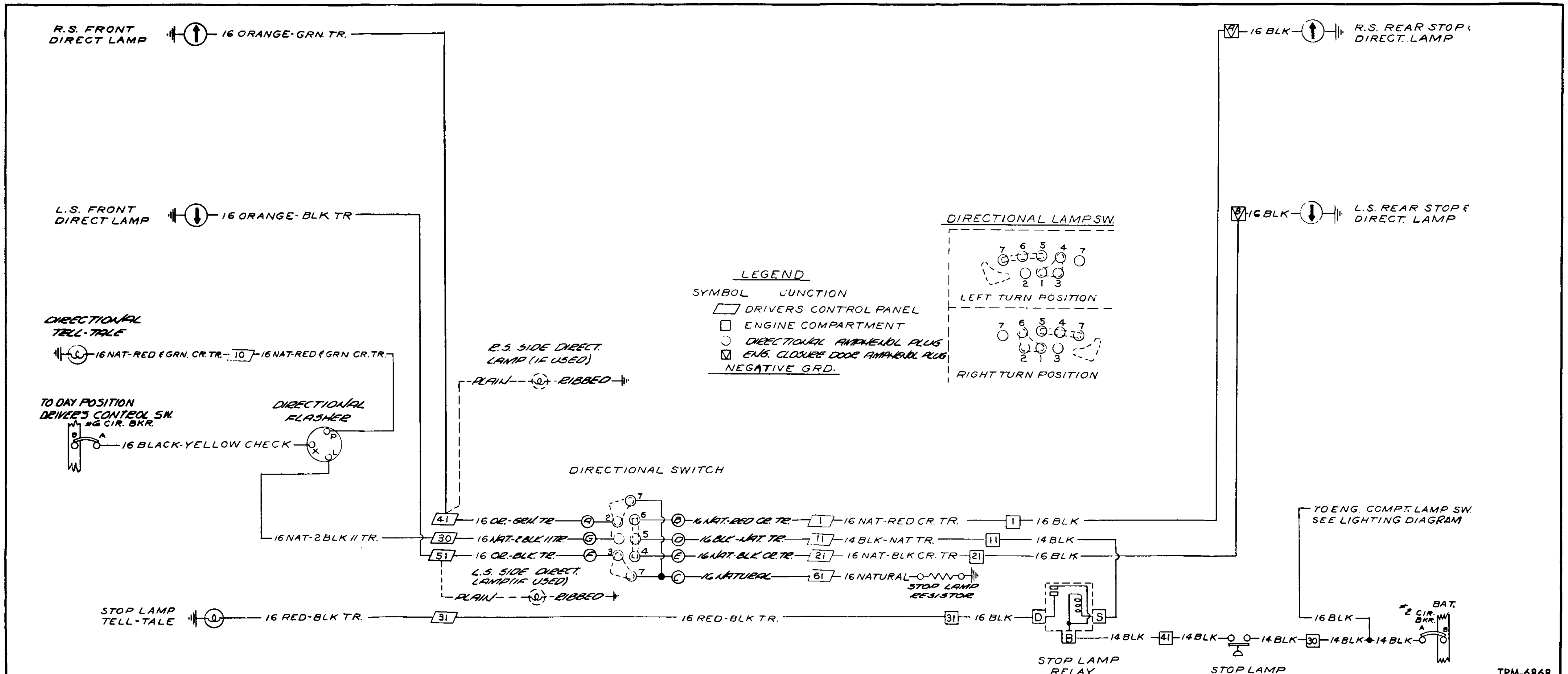
MD-86080A

Alarm and Signal Wiring Diagram



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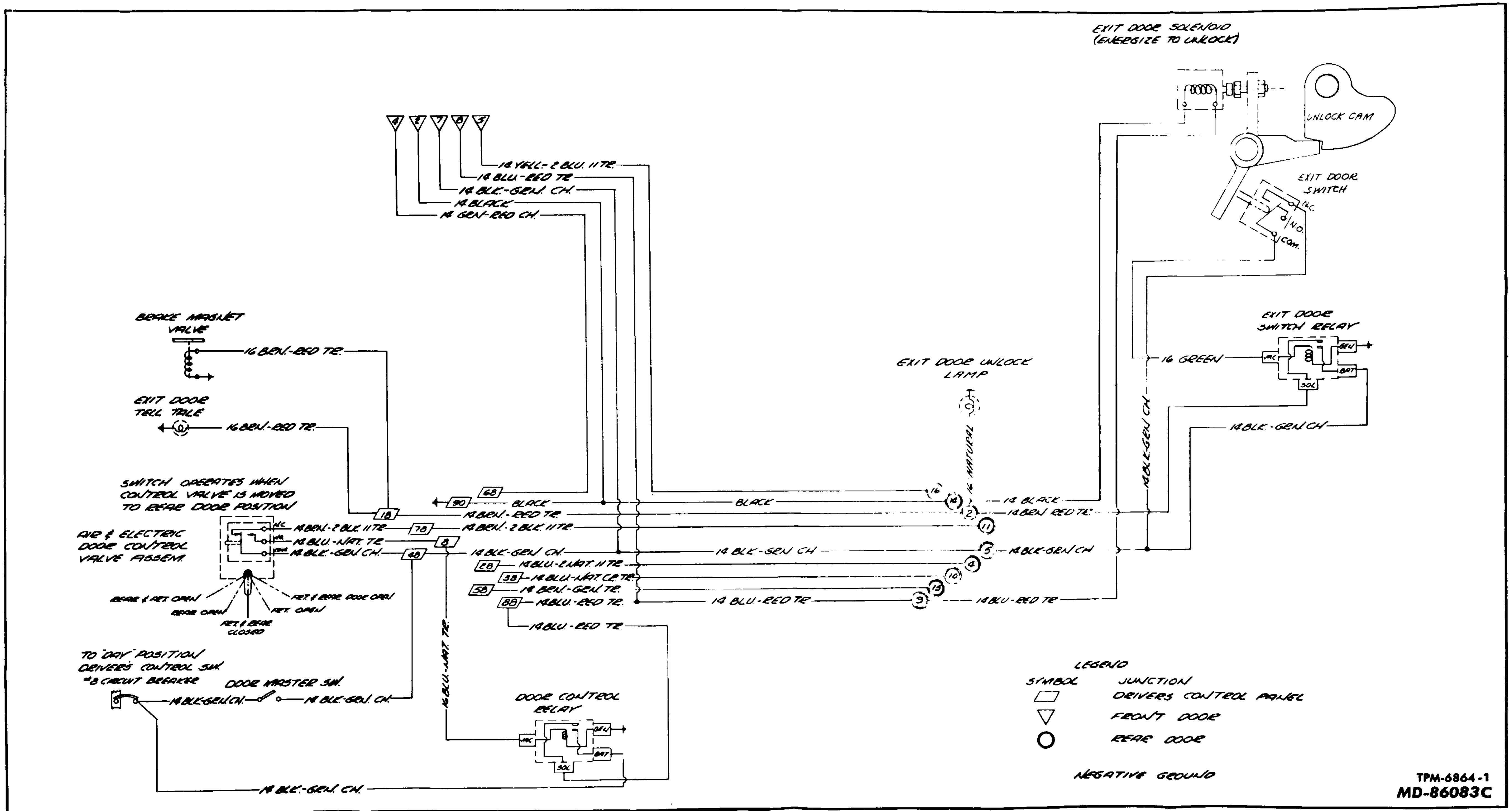
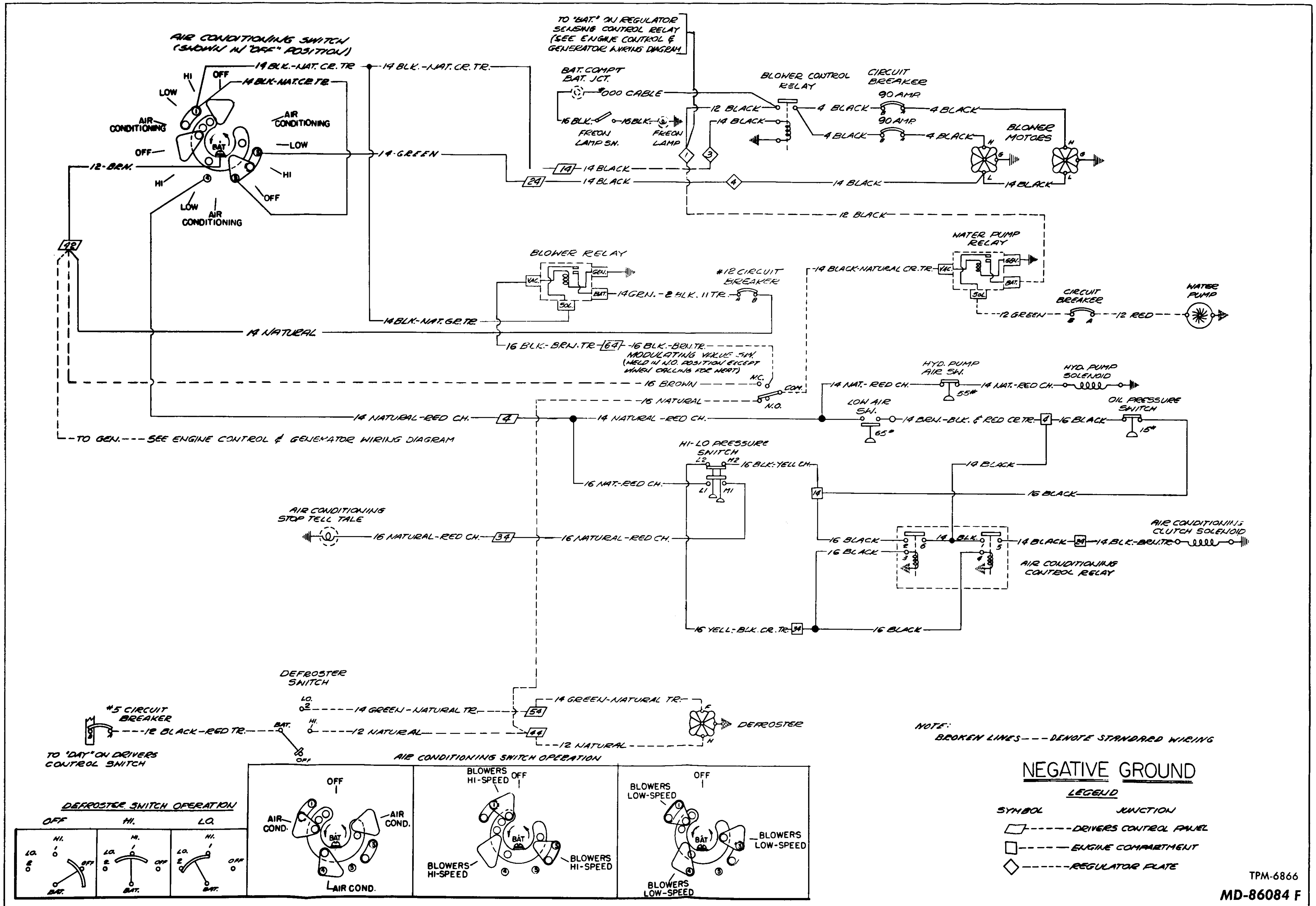
Stop and Directional Lamp Wiring Diagram—Standard



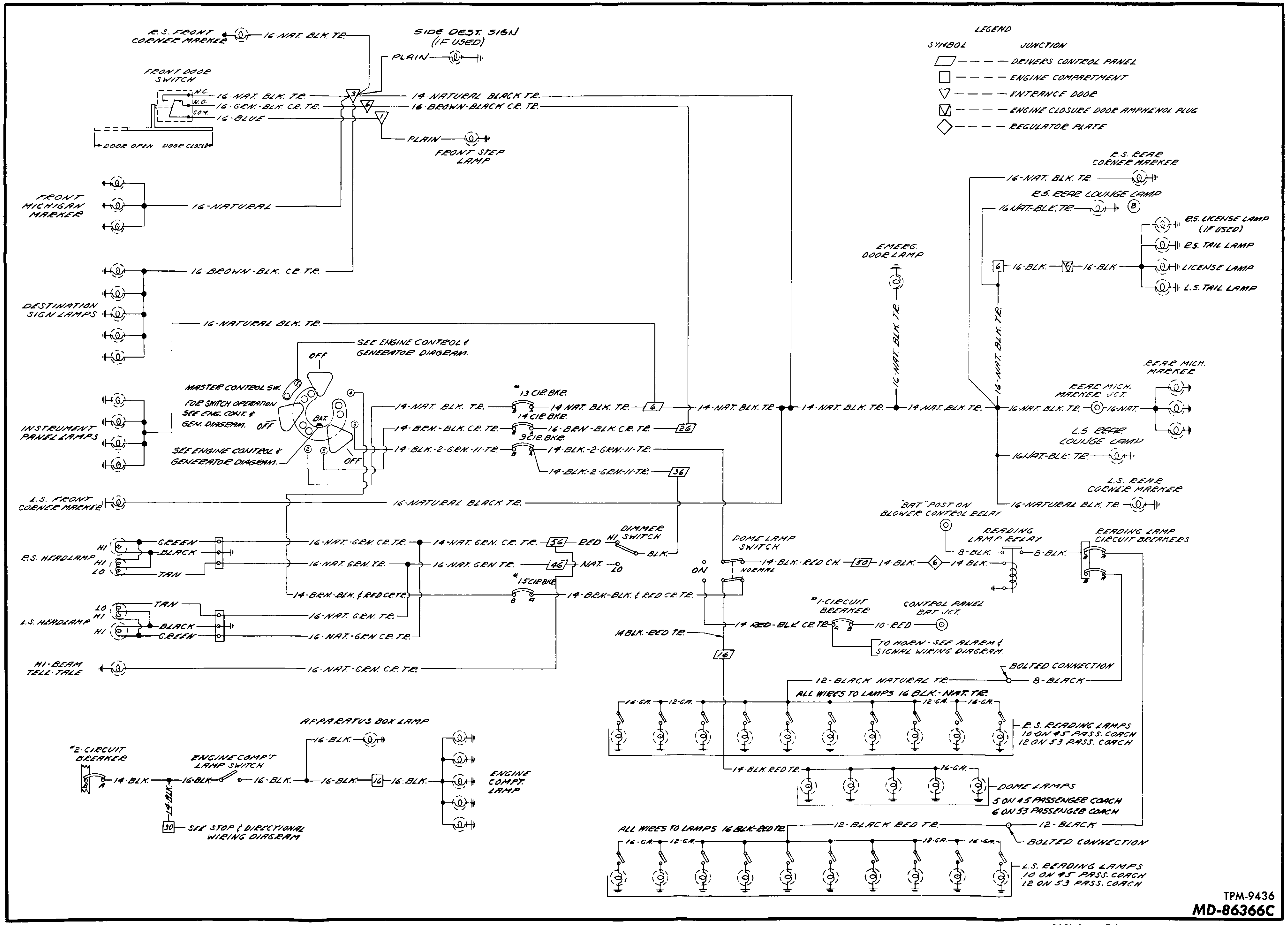
Door Control Wiring Diagram—Standard Equipment only



TPM-6866

MD-86084 F

Air Conditioning Wiring Diagram



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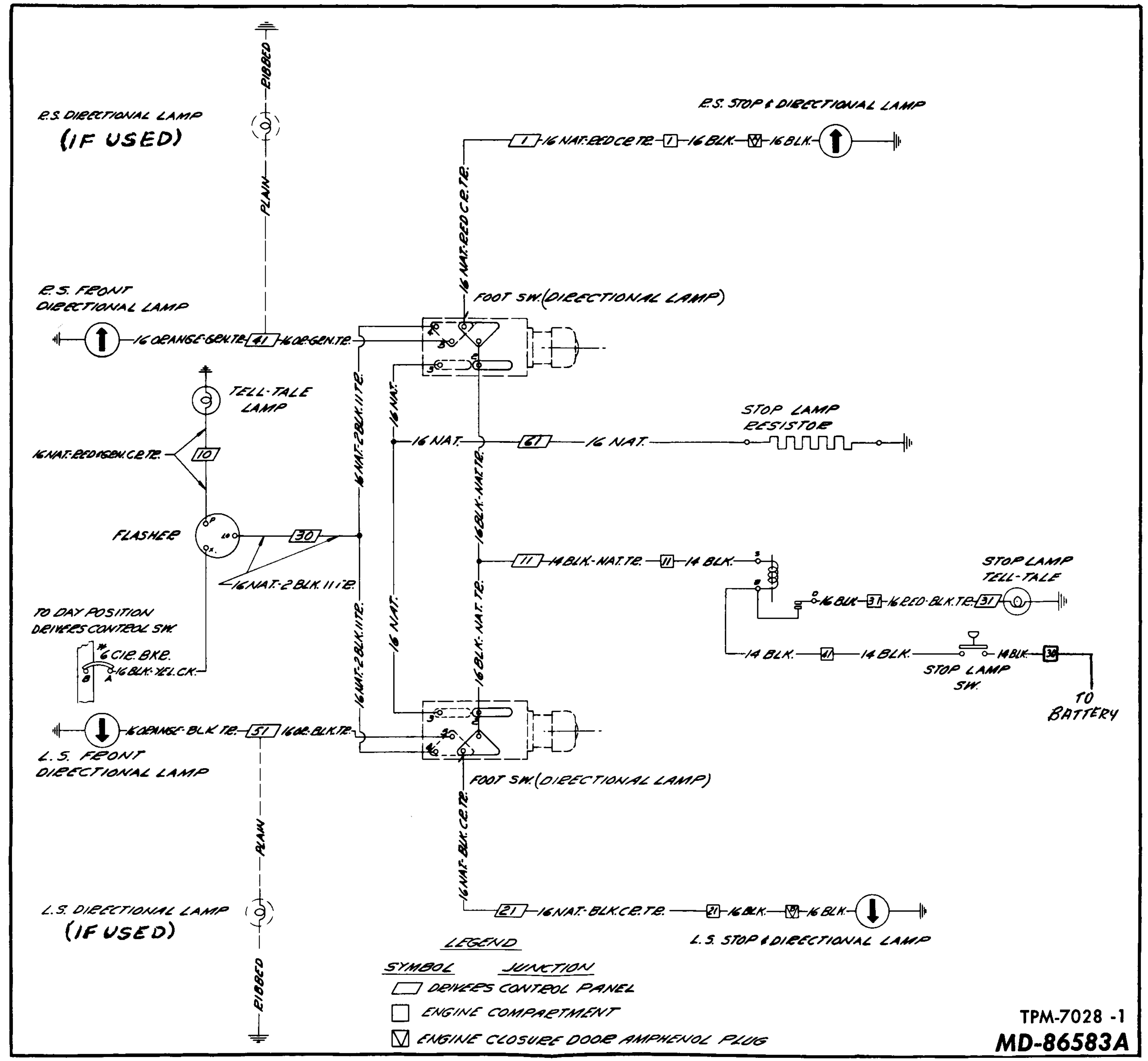
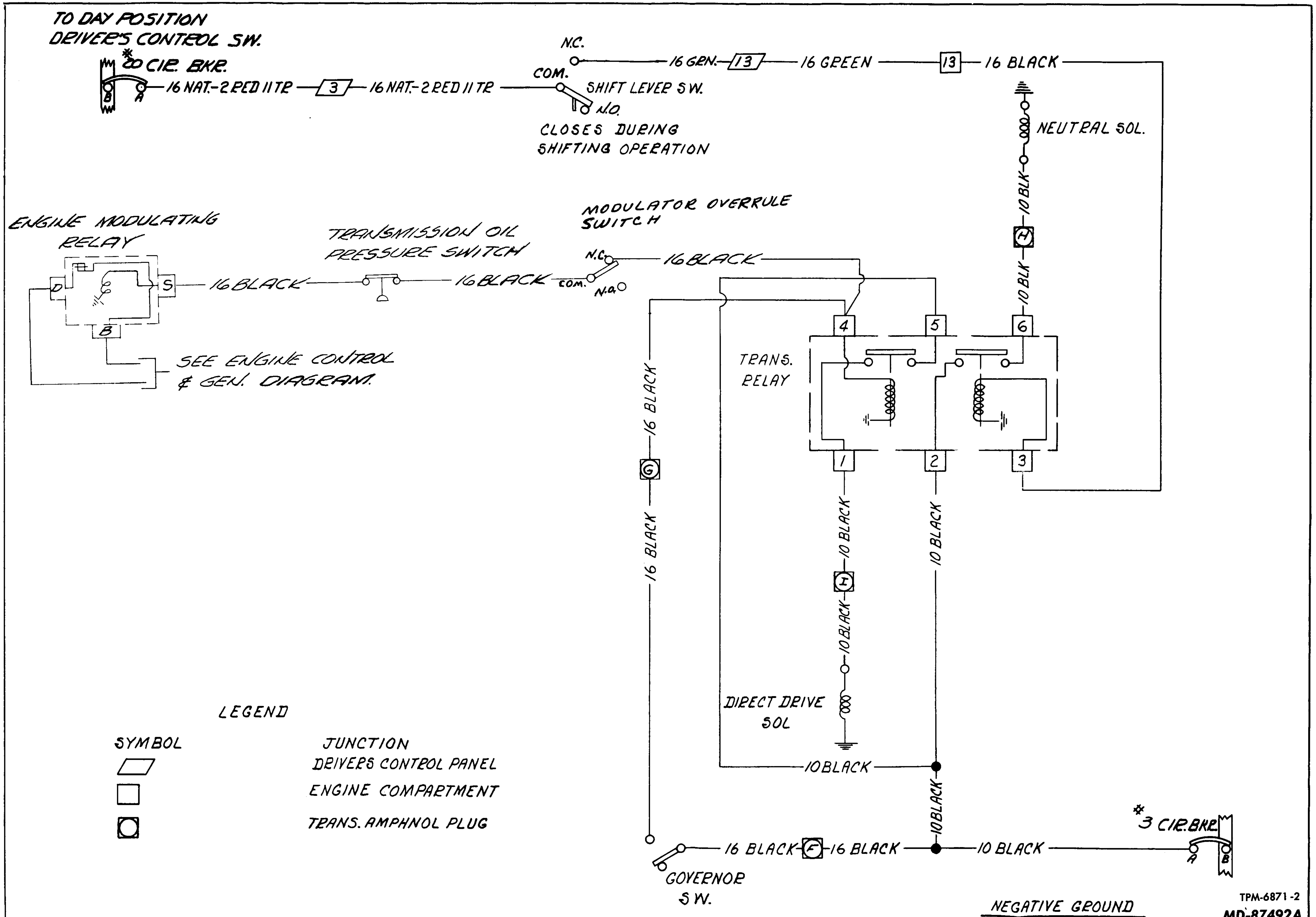
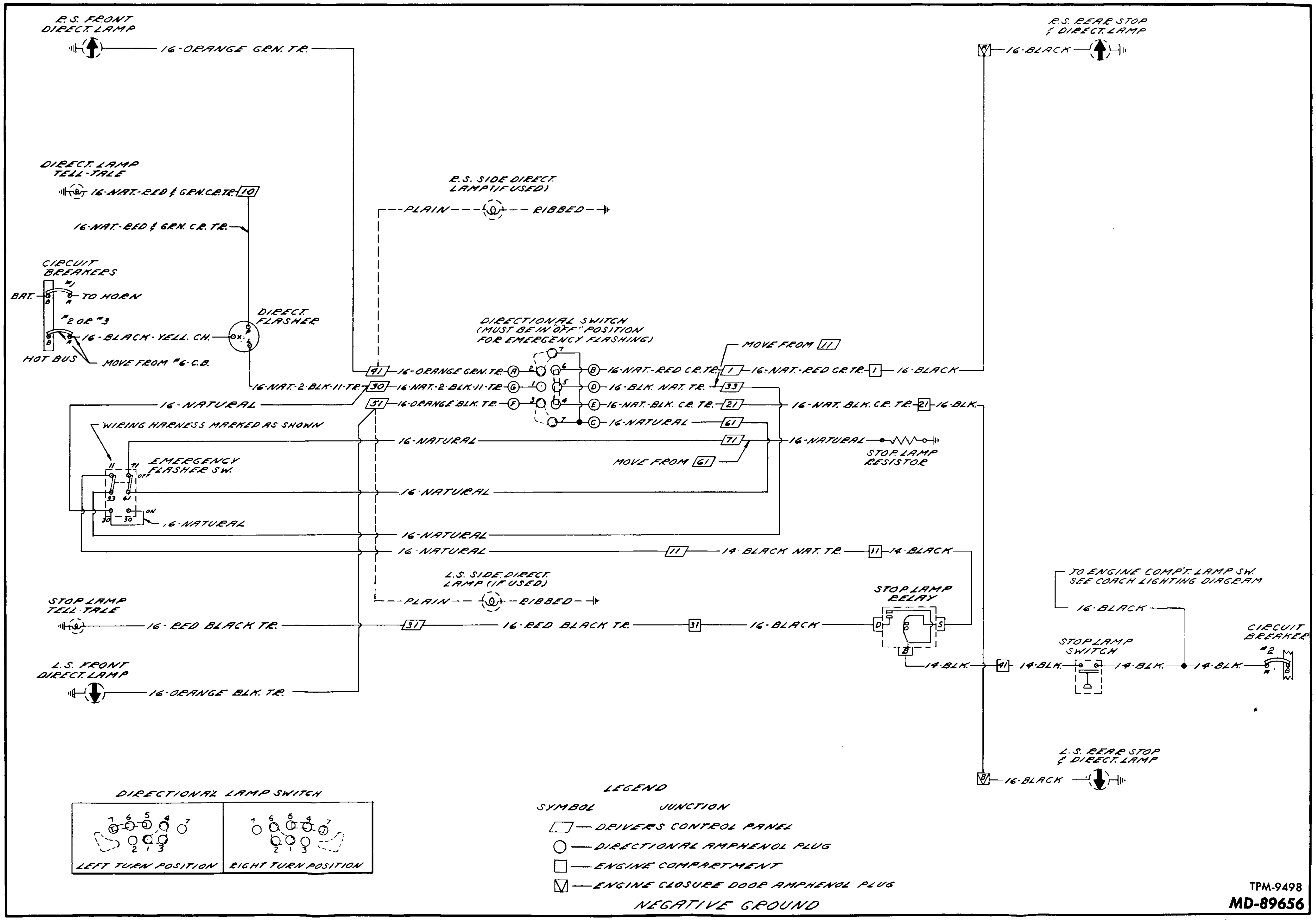
Lighting System Wiring Diagram— SDH and SDM



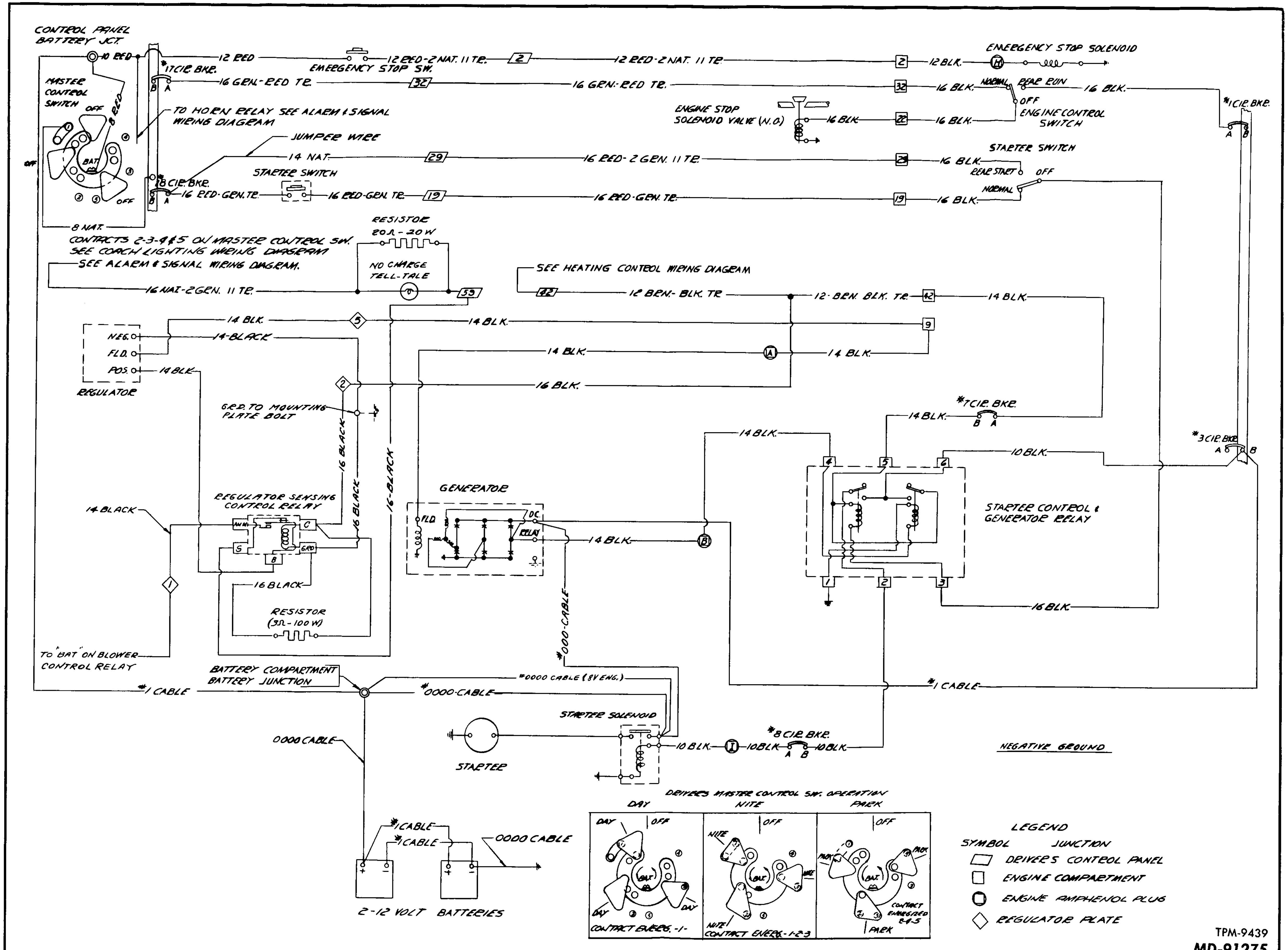
Foot-Operated Stop and Directional Signal Wiring Diagram



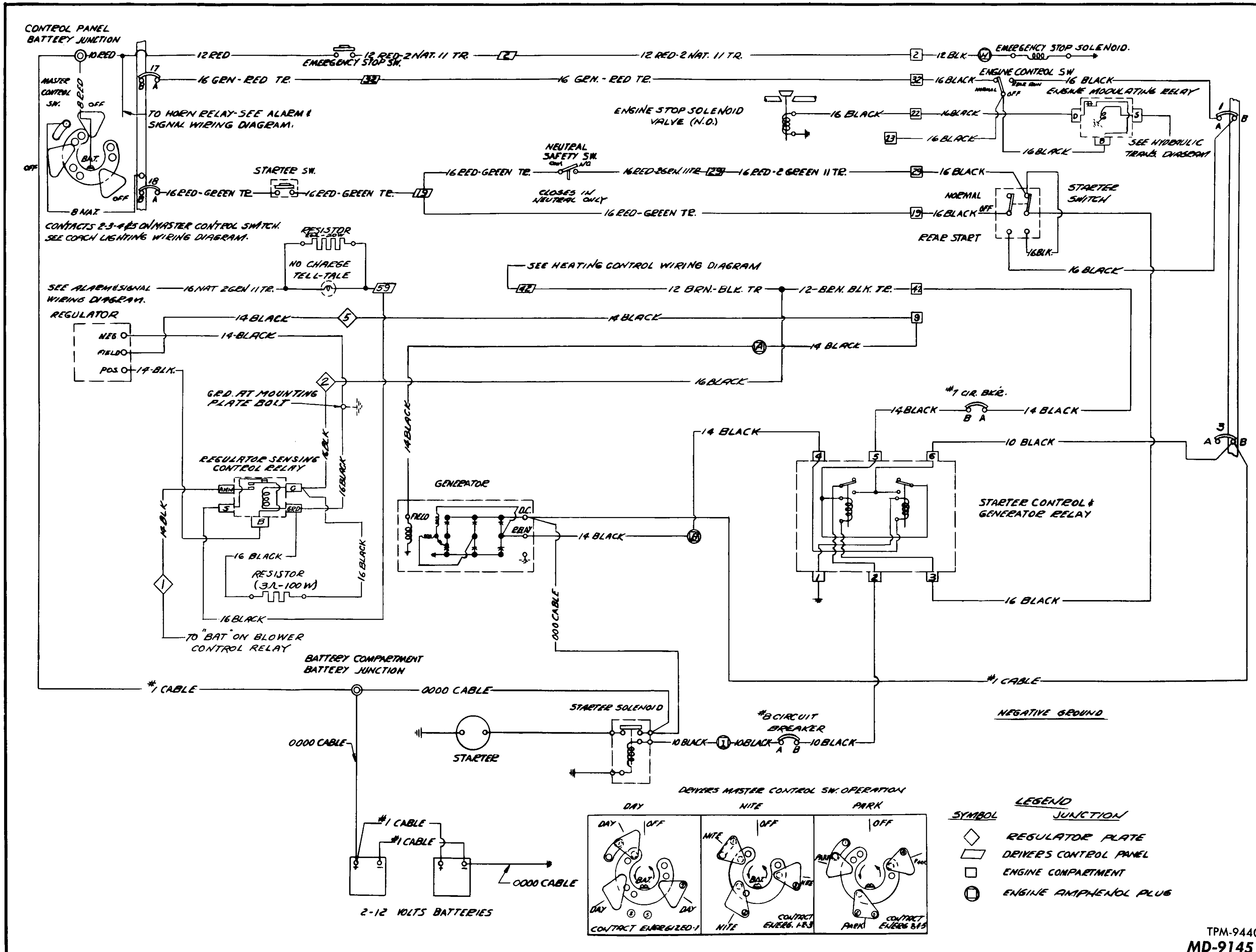
Hydraulic Transmission Wiring Diagram



Stop and Directional Light Diagram With Emergency Flasher System



Standard Engine Control and Generator Wiring Diagram—TDM and SDM



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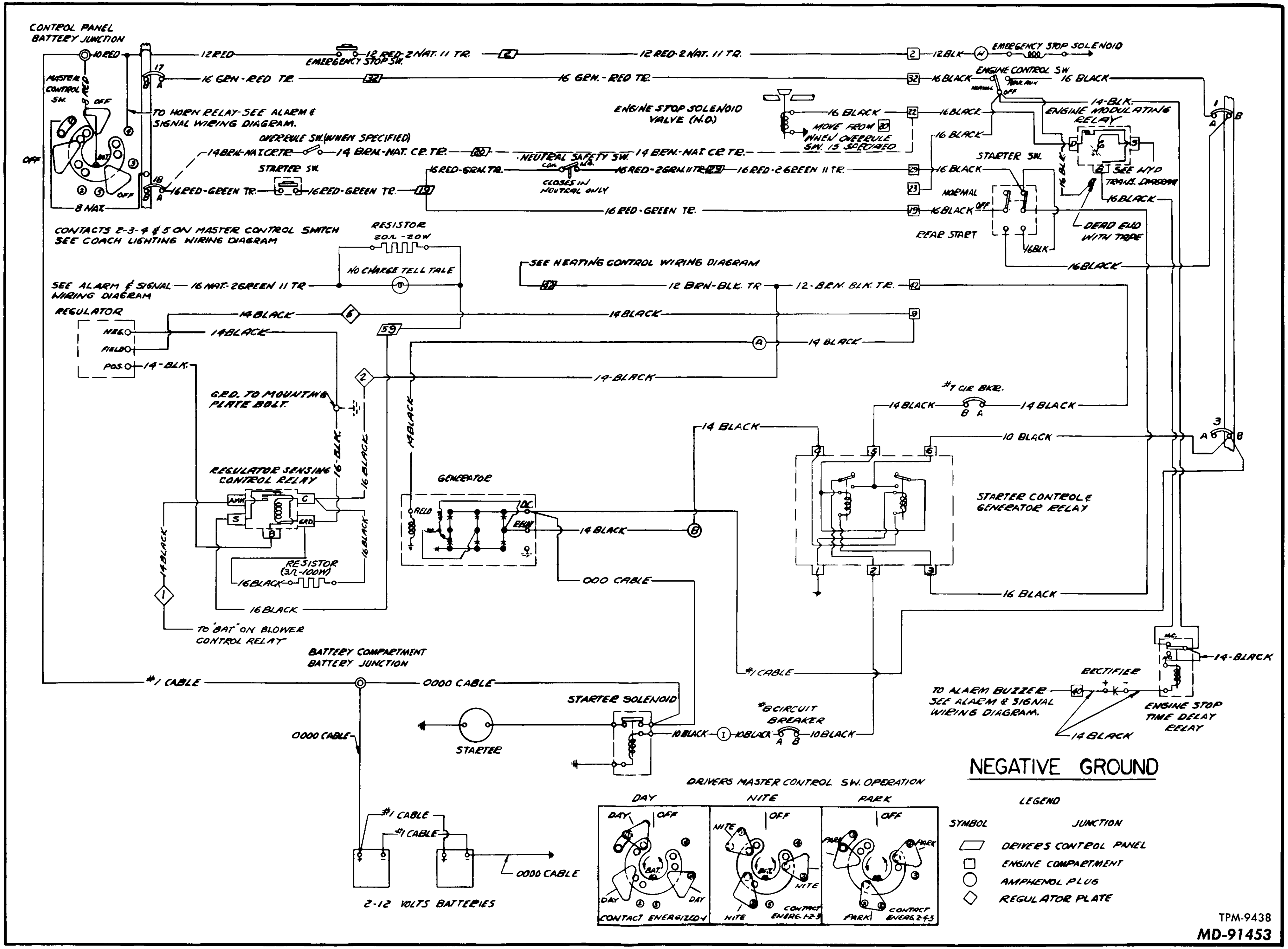
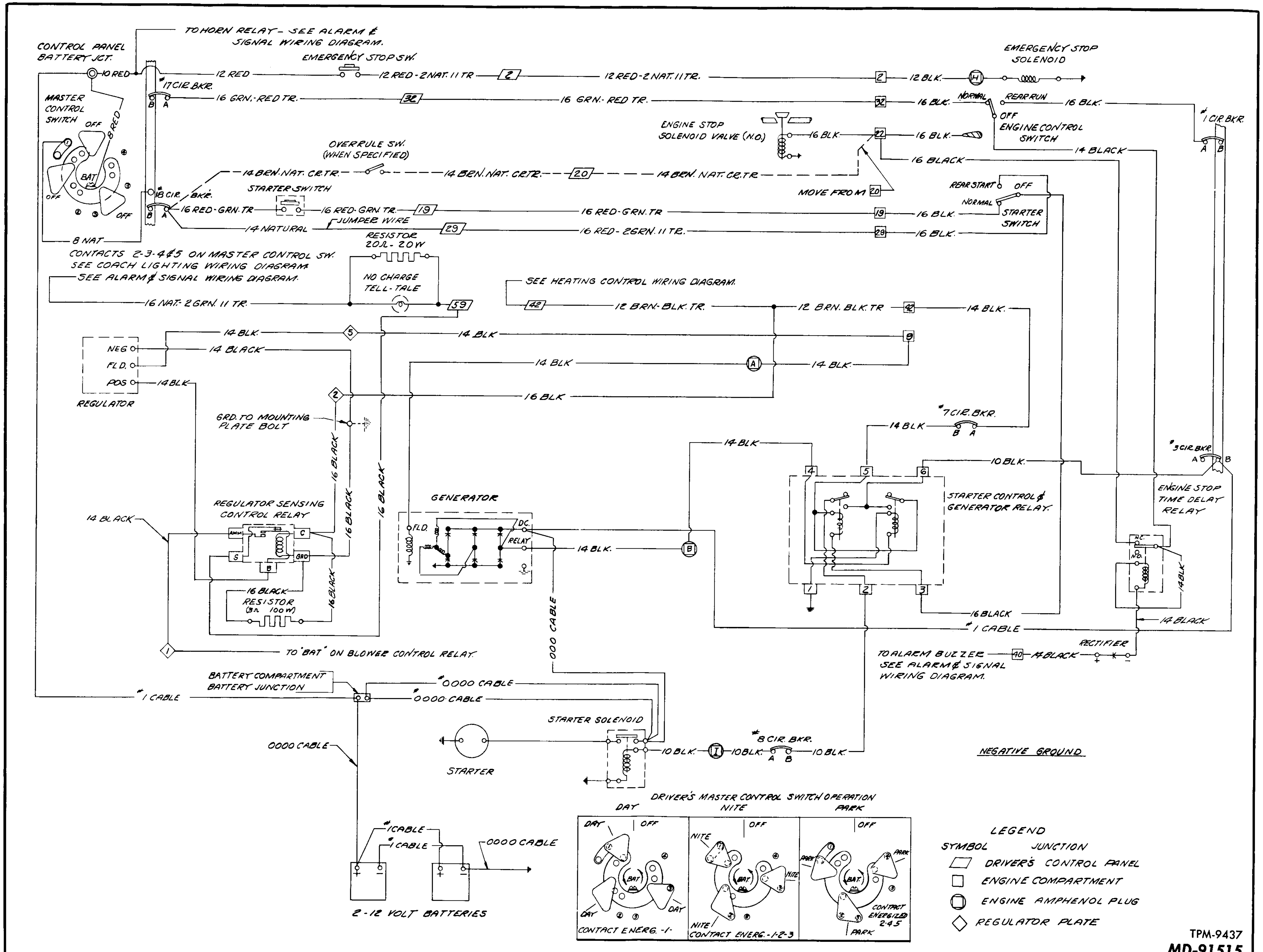
Standard Engine Control and Generator Wiring Diagram—TDH and SDH



Engine Control and Generator Wiring Diagram—With Automatic Engine Shut-off—TDH and SDH



Engine Control and Generator Wiring Diagram—With Automatic Engine Shut-off—TDM and SDM

Lubrication Chart

MODELS TDH-4516, 4517, 5301, 5302, AND SDH-4501, 5301

Item No.	Item	Remarks & Capacities	Miles	Symbol
1	Engine	Keep to "FULL" mark - 27 Qts.	Daily	E
2	Engine Oil Filters	Replace Element at Engine Drain	4,000	-
3	Blower Air Cleaners	Keep to Level Mark - 2 Qts. Each	1,500	E
4	Control Linkage - Other Than Shutter Linkage	Oil Can, Brush, or Spray	1,500	E
5	Steering Knuckles	Four Fittings - Two Each Side	1,500	C
6	Steering Tie Rod Ends	Two Fittings - One Each End	1,500	C
7	Steering Drag Link Ends	Two Fittings - One Each End	1,500	C
8	Brake Camshafts - F. & R.	Four Fittings - One Each - Apply Sparingly	1,500	C
9	Slack Adjusters	Four Fittings - One Each	1,500	C
10	Accelerator Pedal	One Fitting	1,500	C
11	Accelerator Interlock Lever	One Fitting	1,500	C
12	Accelerator Control Lever	One Fitting	1,500	C
13	Parking Brake Camshaft	One Fitting	1,500	C
14	Parking Brake Relay Levers	Two Fittings - One Each	1,500	C
15	Parking Brake Bell Crank	One Fitting	1,500	C
16	Speedometer Adapter	One Fitting	1,500	C
17	Propeller Shaft Slip Joint	One Fitting	1,500	C
18	Steering Drive Shaft Slip Joint	One Fitting	1,500	C
19	Air Cond. Compressor Drive Slip Joint	One Fitting	1,500	C
20	Door Lower Hinge Pins	Three Fittings - Two Rear - One Front	1,500	C
21	Door Upper Hinge Pins	One Fitting Front - *2 Fittings Rear	1,500	C
22	Power Steering Cylinder Ends (When Used)	Two Fittings	1,500	C
23	Destination Sign Gear and Chain	Apply Sparingly	1,500	C
24	Power Steering System (When Used)	To Level Mark on Dipstick	1.500	S19
25	Battery Slide	Apply	As Req'd.	C
26	Battery Terminals	Keep Coated	As Req'd.	S3
27	Rear Axle Differential	To Level of Filler Plug	1,500	MP
		Drain and Refill - 26 Pts. - 53 Pass.	15,000	MP
		Drain and Refill - 22 Pts. - 45 Pass.	15,000	MP
28	Propeller Shaft "U" Joints	Two Fittings - One Each Joint	1,500	G
29	Steering Drive Shaft "U" Joints	Two Fittings - One Each Joint	1,500	G
30	Air Cond. Compressor Drive "U" Joints	Two Fittings - One Each Joint	1,500	G
31	Steering Bevel Gear Housing	Fitting - To Level of Breather	1,500	SG
32	Steering Gear Housing	Fitting - To Level of Breather	1,500	SG
33	Starter	Thru Plug - Commutator End	3,000	E
		Thru Plug - Drive End	At Inst.	E
34	Air Cond. Clutch Air Cylinder	Thru Plug Opening - 1 Oz.	10,000	E
35	Wheel Bearings	Hand Pack or Use Lubricator Do Not Use Pressure Gun	15,000	S2
36	Brake Shoe Anchor Pins	8 Fittings - 2 Each Wheel	15,000	S2
37	Transmission	Refer to GM Hydraulic Drive Manual (Model VH) Check Level	3,000	
		Drain and Refill	25,000	
38	Air Cond. Condenser Fan Drive	See "Instructions"	-	S19
39	Air Cond. Compressor	See "Instructions"	-	S25
40	Air Cond. Compressor Clutch Shaft	Pack at Assembly	-	S26
41	Speedometer & Tachometer Cables (When Used)	Coat Inside Cable	25,000	SG

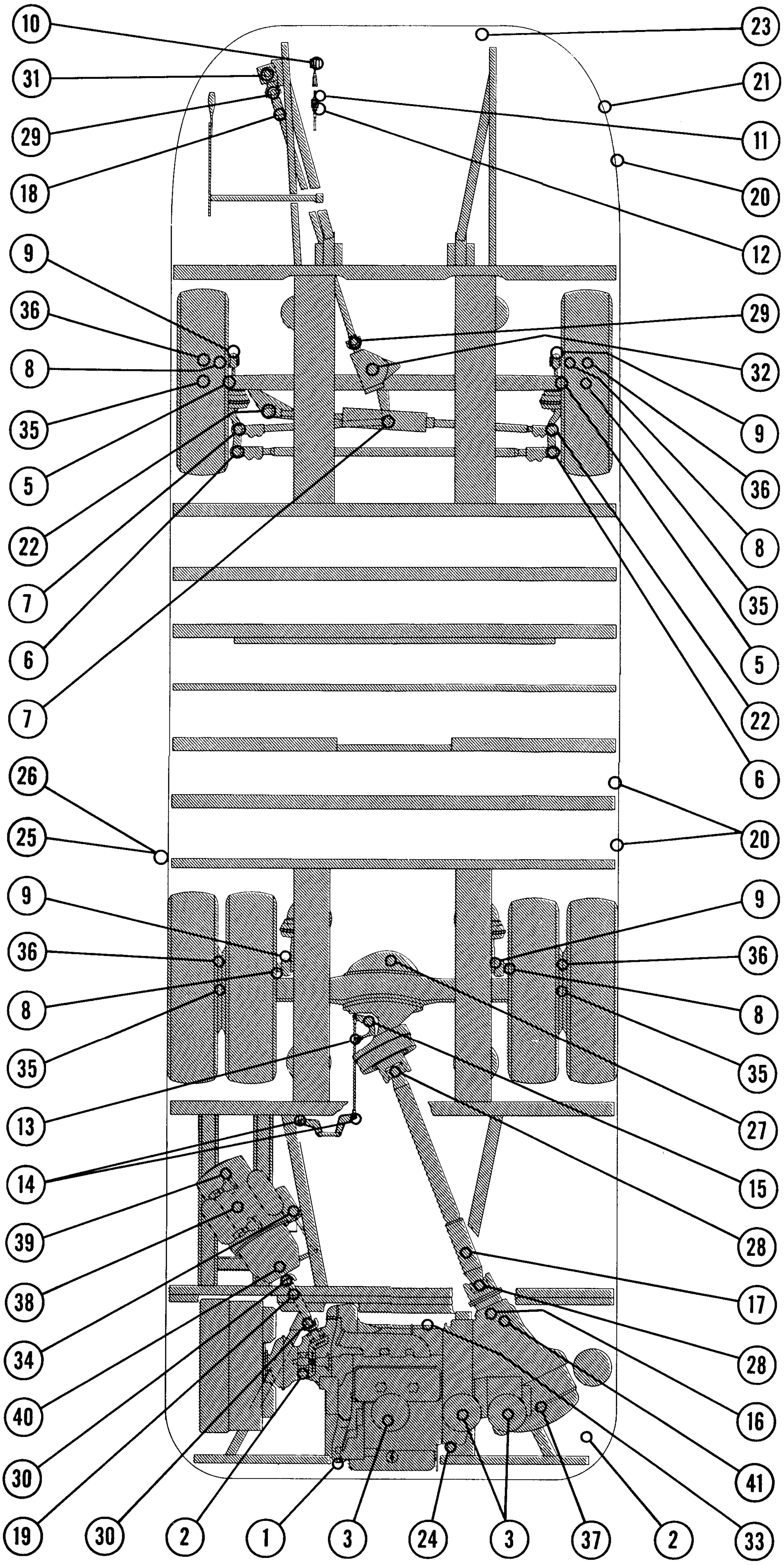
* Push Type Doors Only.

X-6215

LUBRICANT SYMBOLS

E - Engine Oil
MP - Multi-Purpose Gear Lubricant
G - Straight Mineral Gear Lubricant
C - Chassis Lubricant
SG - Steering Gear Lubricant

S2 - High Temperature Grease
S3 - Petrolatum - Petroleum Jelly
S19 - Type A Fluid
S25 - Air Conditioning Compressor Oil
S26 - Special Multi-Purpose Grease



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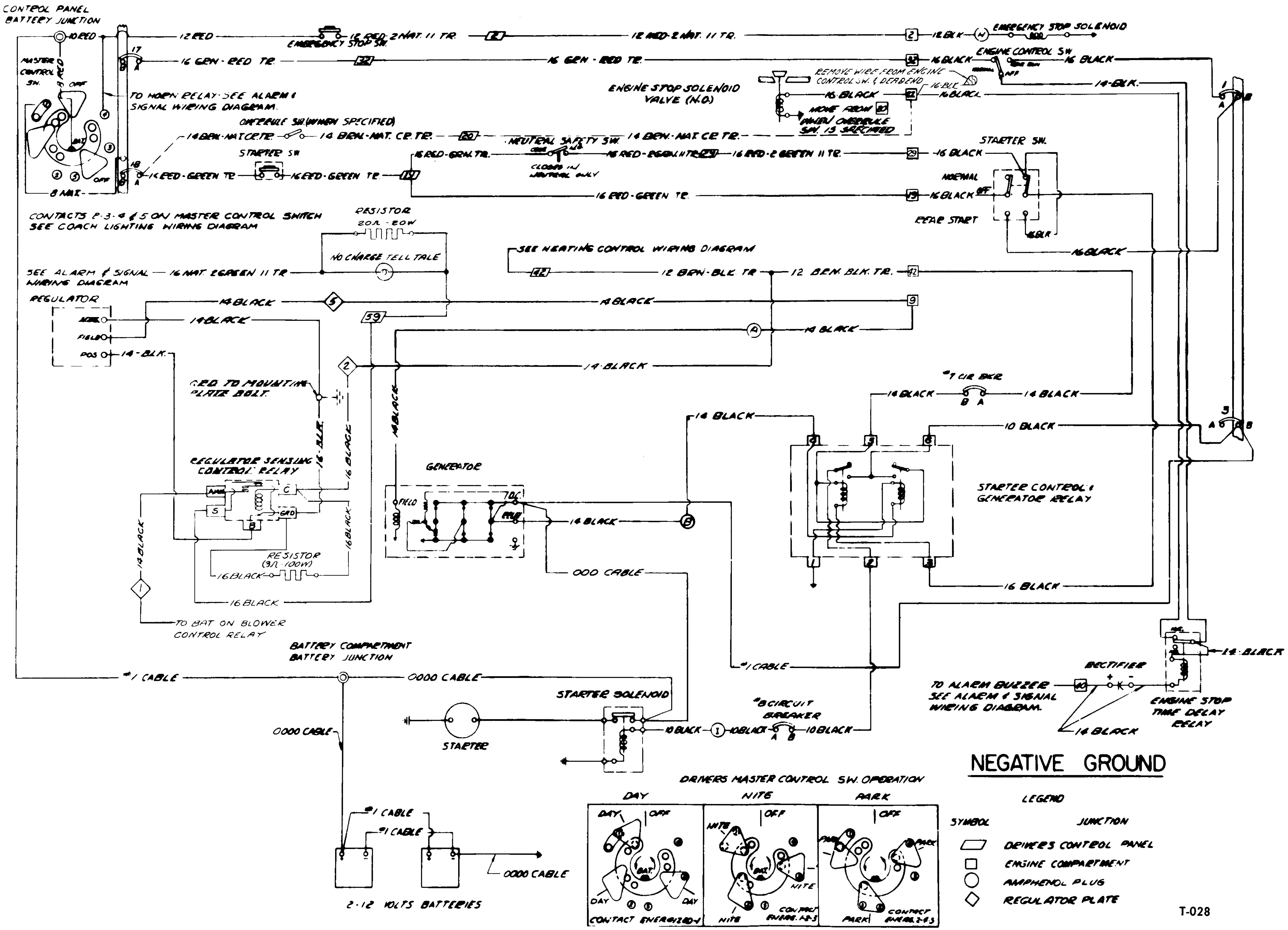
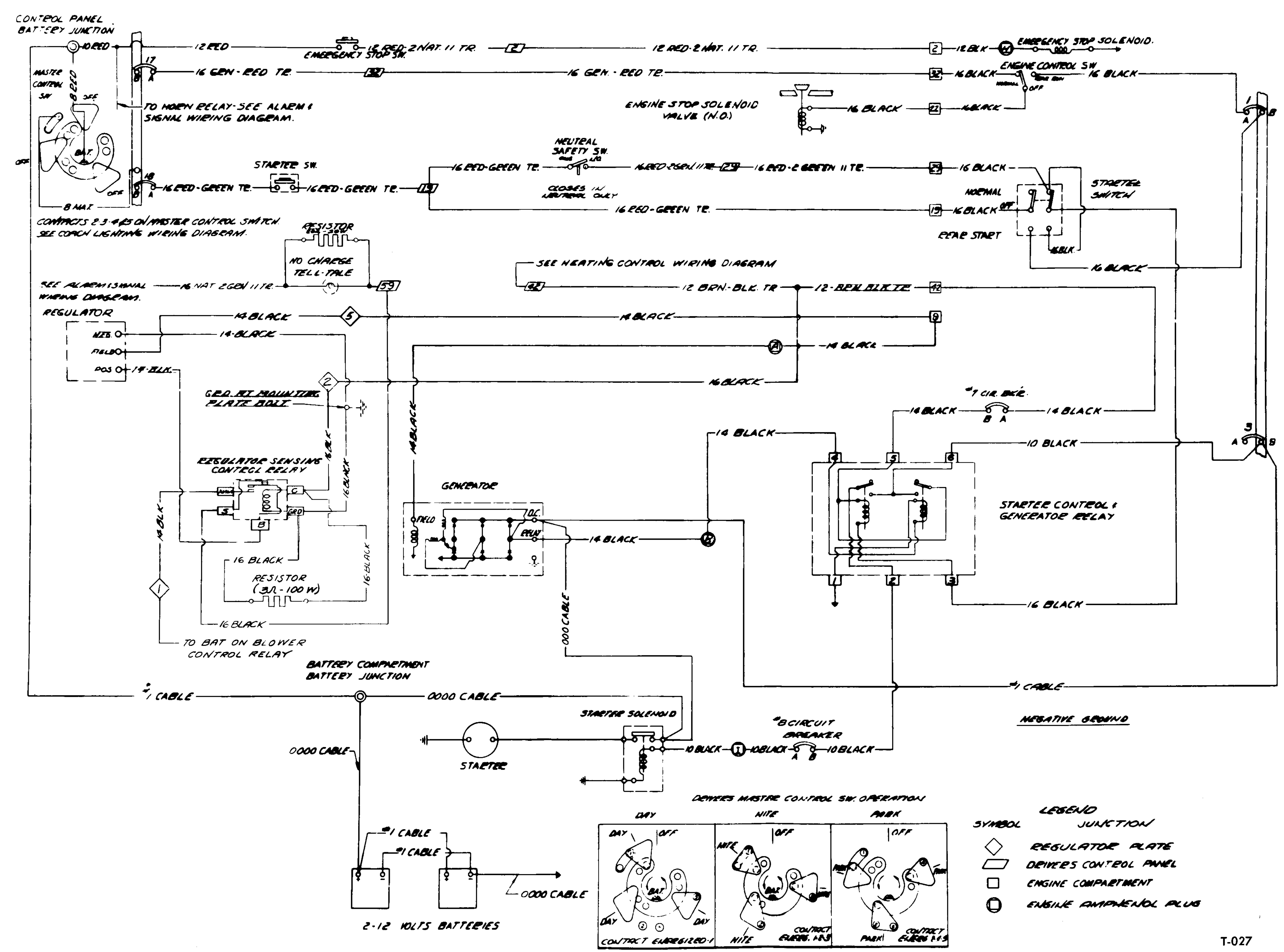


Engine Control and Generator Wiring Diagram - With Automatic Engine Shut-off System - TDH and SDH Models - MD-92663



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Engine Control and Generator Wiring Diagram - Standard TDH and SDH Models - MD-92662